POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

Contents

Front Cover

Power for Grand Central Terminal in New York. One of the most difficult and intricate pieces of work ever undertaken in New York was the removal of the Grand Central Terminal Boiler Plant and substation from its former location to a deep underground location at 43rd and Lexington Ave. This shows a small portion of the huge converter room. Photo, Ewing Galloway.

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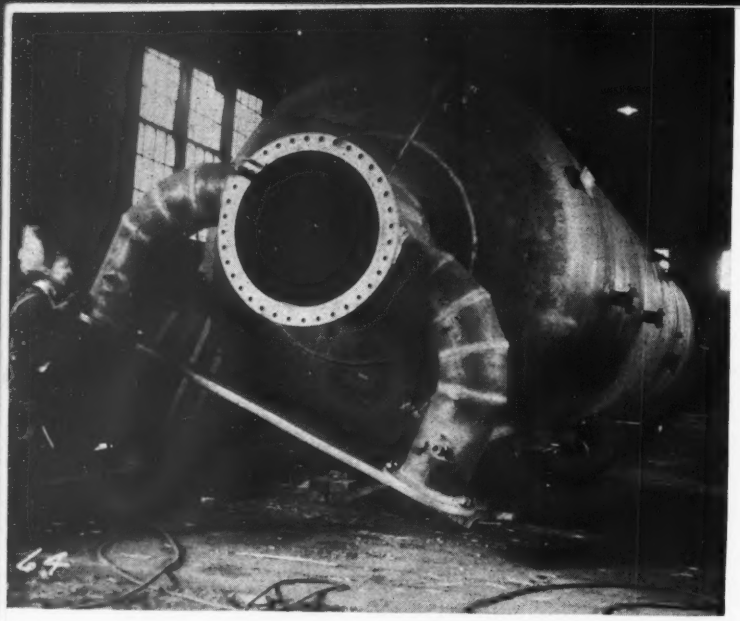


Another Chapter in UNNATURAL HISTORY

NOTHING is more beautiful to contemplate than the harmony and self-sacrificing devotion to science that prevails in our Unnatural History Department. It would be unbecoming of us to boast and we dislike to talk about ourselves but in all modesty and without exaggeration we can say that our staff of unnaturalists ranks second to none anywhere on this planet. Through years of unremitting effort and with diligence that can only be described as superhuman, this small but valiant group has made more unnatural discoveries and uncovered more perfectly useless information than can be found even in the Congressional Record, and that, dear reader, in the vernacular, is "saying a mouthful." Time has meant nothing to these men. When Einstein enunciated his famous theory of relativity disclosing the interrelation of time and space, their only comment was, "So what?" We cite this merely as an example of their wisdom and penetrating insight into the nature of things.

Twice during the last two years through the medium of POWER PLANT ENGINEERING, they rocked the world, figuratively speaking, with their startling discoveries of the Dieselosauras Scavengeritis and the Elephas Turbinas in Beloit and Schenectady respectively.[1] So great was the uproar resulting from these discoveries that the staff was forced into seclusion almost at once. This shows the force of public sentiment. But such stuff as our unnaturalists are made of will assert itself and in the seclusion of their upholstered laboratories they planned their next move.

This came quite unexpectedly and for some weeks after it took place all trace of them was lost, but then one evening a riot call was turned in at East Chicago, Indiana—from the plant of the Graver Tank and Manufacturing Co., of all places! The exact nature of the disturbance was a mystery until the gendarmes found their way into one of the fabricating shops and there, their eyes met a strange sight. For there was our Unnatural History Staff engaged in active research upon a most astonishing object. It seems that in their search for the unusual they somehow had got past the watchman at this plant and in going through the shops had come across the strange beast pictured above.

Recognizing it at once as a find of unusual importance, they set about classifying it in their accustomed quiet and dignified scientific manner. As in all matters of this kind there was some doubt regarding its exact status and this precipitated a discussion—an argument, in fact. Our Chief Unnaturalist insisted that the beast was a member of the extinct Evaporatus Platyhelminthes. This view, however, was not shared by other members of the staff. Several of the experts, pointing to the two short front legs claimed that these proved it to be a petrified Graver Catta Pilosa, a contention which was further substantiated by the abdominal projections on the sides.

"Graver Catta Pilosa, me eye" shouted the Chief in his calm, quiet way, "who ever heard of one of them birds in East Chicago? You guys is full of Siwash!"

"Oh, is that so?" yelled the Pilosa contenders as one of them playfully hit the Chief between the eyes with a drift pin. At this point, however, the Chief's yes men rallied to his support and began hurling six inch bolts at the opposition who thereupon sought refuge inside the Catta Pilosa or whatever it was.

This at once gave the Chief and his aides a splendid opportunity to test the acoustic properties of the creature and they began to pound it with sledge hammers—these, happened to be lying nearby.

It is unfortunate that at this point the police broke their way into the shop, for cops, it is well known, are constitutionally opposed to research and they put an end to further experimentation. "In th' wagon wid yoose nuts," they shouted, very unsympathetically, and ———

Well, as a matter of fact that ends the story. Once again, breath taking history was nipped in the bud and what might have been a discovery of startling importance proved to be only an every day matter at the Graver Tank and Mfg. Co.

"Yes," said an official of that company later. "It was not a petrified beast at all, simply a 60 ft. evaporator tower for the Chalmette Petroleum Corp. We build such equipment every day and think nothing of it. It's all in the day's work."

[1]Startling Developments in Unnatural History, April 1935, page 204. Further Progress in Unnatural History, June 1936, page 320.

WITH THE EDITORS

Strife Within and Strife Without

SIGNIFICANT indeed, to users, engine manufacturers and utilities, is the recent decision of the Peoples Gas Light & Coke Co. of Chicago to enter the power generating field in direct competition with its erstwhile financial twin, the Commonwealth Edison Co. In itself this would be relatively unimportant if it did not represent the first important step in making highly competitive the smaller industrial and commercial power field which so far has been the exclusive property of the electric utility.

Gas engines, because of lower costs and somewhat simpler installation, are more competitive than the Diesel, especially in the very small sizes where Diesel design has not been fully developed. For the past ten years or more since the natural gas pipe line network started to cover the middle west, there has been an insistent demand for engine rate schedules comparable with those for gas burned under boilers.

Faced with somewhat the same problems, in many cases directly or indirectly related financially, the pipe line, local gas and electric companies have so far successfully resisted this economic pressure, and have discouraged the installation of gas engines. With a special gas engine rate schedule approved by the Illinois Commerce Commission and a start made in such important territory, it is probable that similar action will be forced in all middle western territories, even where gas and electricity are supplied by the same company, as for instance, the near Chicago territory served by the Public Service Co. of Northern Illinois. An immediate and wise decision is of vital importance to the electric utilities.

In the past the utility industry as a whole has not handled competition too wisely, a result perhaps of the trend of recent years which has shifted executive control from the operating group to bankers and lawyers. Utility operators and engineers recognize that there is a certain industrial field with which they cannot compete, a field that is constantly increasing due to technological advances and better engineering, often, by utility trained engineers or engineering companies, who have made a place for themselves in the industrial field.

In many cases it is remarkable that, under the circumstances, so much of the industrial load has been retained. This is due largely to competent sales staffs, albeit undermanned, which have been compelled to fight not only economic conditions, but a tremendous amount of isolated plant propaganda and, often, outmoded company policies that demand all or none of the load.

Lower engine gas schedules will greatly broaden this competitive field and in the interest of power utilization, with ultimate benefit to all parties involved, it is to be hoped that the utilities will meet this new problem wisely. Perhaps no better guide is available than that supplied by a man well known in the industry who built on the principle that: "If we cannot save them money we do not want the job. Sooner or later changing conditions will demand our service and we can then meet them with confidence in each other, secure in the knowledge that any arrangement made is to our mutual advantage."

Power competition from the isolated plant is no myth. What is needed is coöperation to give the power user complete satisfaction at lowest cost and build the power load as rapidly as possible so that all parties may profit. This is perhaps a Utopian dream, but the only alternative is a gradual shrinkage of the utility market to the domestic field to which many feel they should be confined. Power, as the most dominant element of our modern civilization, transcends the desires or dictates of any one group.

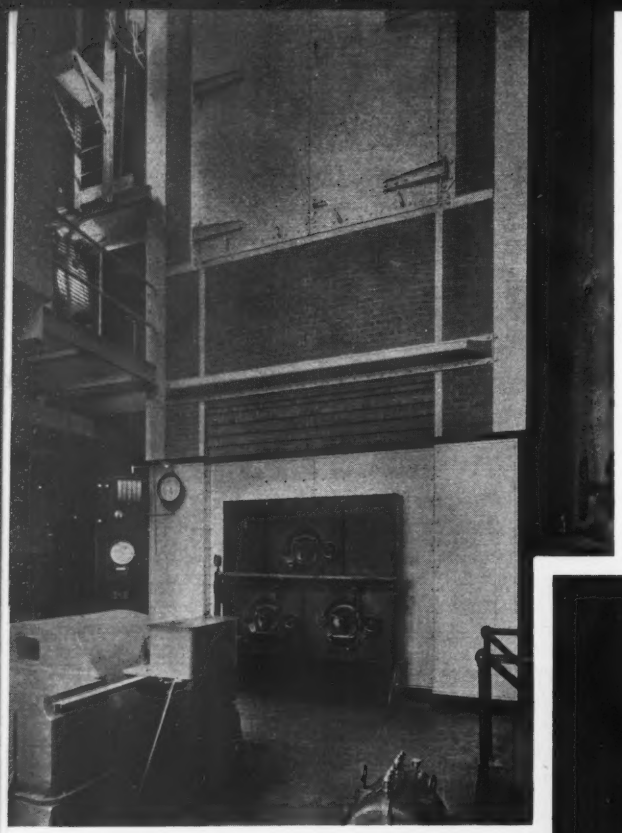
Styles vs. Integration

POWER PLANTS have definite style trends. A few years ago it was large centralized units and long distance transmission. Today it is a multiplicity of small units at the load with an unreasonable fondness for "tops." The political aspect of this was discussed at some length in the January issue and was touched upon by Philip Sporn of the American Gas & Electric Co. at the E. E. I. Convention.

More important, he hinted rather broadly that this style trend was blinding engineers to the opportunities of interconnection and the limiting more complete integration of systems. From anyone else this might be taken as biased opinion but no one can deny that Mr. Sporn knows whereof he speaks and can back his opinions with data. The A. G. & E. can boast a number of successful interconnections, a full range of plant sizes and have not neglected "tops."

Interconnection in the true sense of the word, however, does not mean a tie line or two with mental and physical limitations as to how and when it or they may be used. It is necessary to embrace the philosophy of interconnection which "postulates the idea of mutual help and mutual support in times of need, without stint, up to the limit where the helper himself is jeopardized . . . the philosophy is sound provided you grant that the technique . . . can be so developed as to reduce the self-jeopardy—to neglibible amount.—The technique —has been developed and is being more closely perfected every day."

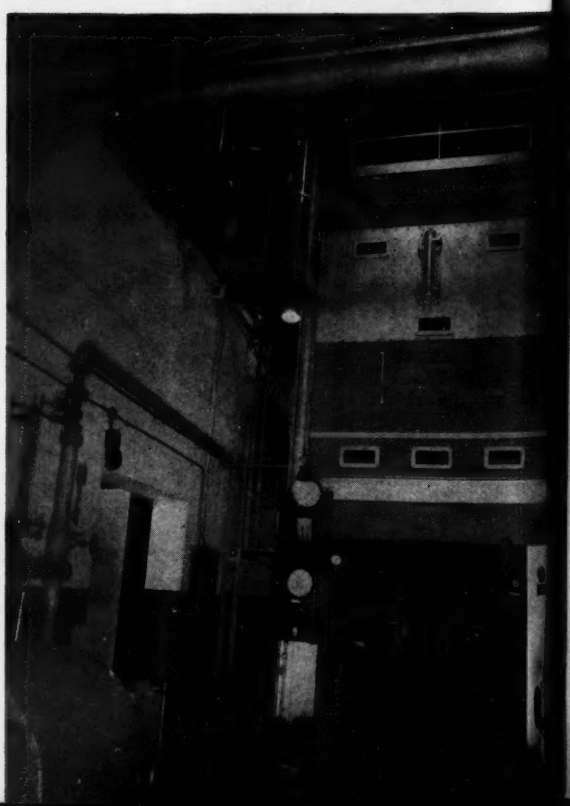
The soundest method of approach is to consider the problem from the standpoint of what would be desirable "if all the properties involved were under a single management or ownership." Strange as it may seem interconnection does not necessarily involve long distance transmission. The weighted mean on the A. G. & E. system operating in nine states, is, under normal conditions, less than 60 mi. "Better service, lower cost service, better protected service and more solidly protected capital investment" are the advantages held forth. Although probably included in the reference to protected capital, it might be further emphasized that the practical lessons of coöperation learned from coordinated operation may be invaluable in helping to present a united front in the trying days ahead.



Sometimes

THE SAME VOLUME WITH ONLY HALF THE FLOOR AREA

IN THESE three photographs are shown views of the old and the new boiler installations at the Simplex Wire and Cable Co. plant. The center picture (Fig. 2) shows the old hand fired boilers in cramped quarters occupying valuable floor space. The other two views show the new oil fired units, the one at the top (Fig. 1) installed in 1931 and the one at the lower right (Fig. 3) the one which has just been placed in service. The new boiler plant occupies an area of only 3400 sq. ft. as compared with 6035 sq. ft. for the old arrangement. This saving in floor space made possible a new passage for internal transportation to the main factory a facility that was badly needed.



It Pays Not to Generate Power

By Philip Morss

Vice President, Simplex Wire & Cable Co.
Cambridge, Mass.

VOLUMES have been written regarding the relative merits of private versus purchased power in industry and arguments have waxed fast and furiously over the same question wherever engineers have gathered, but after all has been said and done, the problem resolves itself into one governed by individual circumstance as is the case with all things in this world. In considering the power problem, it is the engineer's duty not to proclaim the virtues of one method over another, but merely to recognize which one of several methods is best from a dollars and cents standpoint for the conditions with which he is concerned. It is the engineer's function to evaluate each possible method in terms which can be weighed against factors which are inherent in the industry or particular plant he is concerned with. The question of lowest power cost is not always one measured in terms of thermal efficiency or even cents per kilowatt hour; rather it is one of determining how the power requirements can be met with the least addition to the total cost of operation. Often the space which would be occupied by a power plant is of considerably greater value to the factory than it is for purposes of power production and in such cases it is advantageous to purchase power even at higher cost per kilowatt hour. It is this aspect of the industrial power problem that determines the power policy of the plant discussed in this article.

As will be shown, this factor of space is, and has been, a very important factor in shaping the power program of the Simplex Wire and Cable Co. plant at Cambridge, Mass., through its 49 years of existence. Built in the heart of a city where expansion is strictly limited in many directions, the space factor has always been of paramount importance and always had to be considered whenever the need for more power arose. The new 2740 sq. ft., three drum, boiler which has just been installed in this plant is a particular feature of interest in this article, not so much in itself, since it is a standard boiler with no unusual features, but in that it represents the last step in the modernization of the steam generating equipment at this factory.

Plant Dates Back to 1899

This factory had its beginning in 1899 in what was then the Morss Wire Works, the parent organization of the Simplex Co. At first 2 H. R. T. boilers and two 80 hp. engines supplied the power, but between 1899 and 1907 there was installed a steam power plant totaling 1100 hp., consisting of four straight tube long drum boilers rated 275 to 400 hp. each, five compound engines and a 200 c.f.m. steam driven air compressor.

Two of the engines of 250 hp. each drove lines of rubber mills. These were known as engines Nos. 1 and 2 and are shown in the photograph in Fig. 5. The other three engines were connected to D.C. generators, varying from 75 to 200 kw. This installation was carefully worked out and represented the up-to-date practice of its day, though the president of the company once remarked that the scheme was so complicated only he and the old master mechanic who took care of it ever understood it.

The arrangement of the plant at this time is shown in Fig. 4. The two 250 hp. engines driving the rubber mills are shown at the left. These, as well as engines Nos. 3 and 4 driving generators, were all Fitchburgh, horizontal, tandem compound units. No. 4, it will be noted, was located on the other side of the boiler rooms. Engine No. 5, which also drove a 150-kw. d.c. generator, was a Westinghouse, vertical compound machine, rated at 225 hp.

This plant operated for 20 yr. and the factory which it served grew with the development of the electrical industry and the increasing need for wire and cable. About 1912 the power plant became overloaded and plans for expanding it were drawn up.

These plans, however, never materialized. A radical step was taken when these plans were scrapped and the company began buying a.c. power. There were strong reasons for this change. First, the factory is built in comparatively small city blocks and the steam plant occupies space in the largest manufacturing block; therefore, the steam plant could only be expanded by stealing valuable manufacturing space. Secondly, all coal had to be brought to the plant by truck, obviously an expensive method of delivery and thirdly, there was no condensing water available. In many places where a large amount of exhaust steam is necessary this would not be an unfavorable factor but at this plant where the use of exhaust steam is limited to building heating and was largely wasted in summer time, it was decidedly unfavorable.

This arrangement with part purchased and part generated power continued during the war years, and the increasing load requirements were met by the purchase of more power from the local utility com-

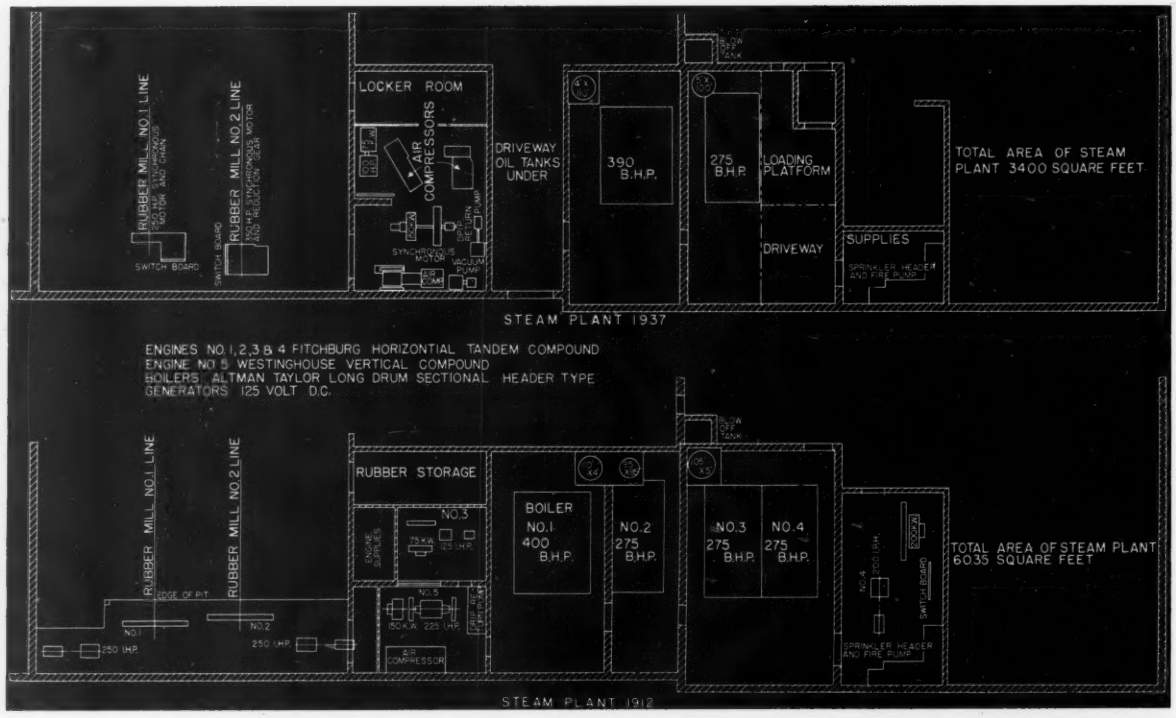


Fig. 4. Drawing showing arrangement of plant today as compared with the earlier arrangement.

pany. Up to this time all boilers were hand fired but in 1922 two single retort stokers were installed to replace hand firing on No. 3 and 4 boilers.

By 1924 the purchased power load had increased to such an extent that it became desirable to buy primary power and so equipment was installed to take purchased power at 13,000 v.

Generating Equipment Scrapped

The first scrapping of generating equipment occurred in 1925 when the high speed Westinghouse engine driving the 150-kw. d.c. generator was replaced by a synchronous motor in order to obtain an improvement of power factor. Since that time, enough other synchronous motors have been installed to bring the power factor up to about 95 per cent or above.

In 1926 the breakdown of No. 1 rubber mill engine started a scrapping policy, and within a year all four engines were eliminated either by installing motors or by changing d.c. load to a.c. so that by 1928 only the air compressor and the 150-kw. generator remained.

In 1927 a beginning was made on metering all outgoing steam. At the same time about a dozen clock-thermostats and motor-operated valves were installed to control building heat, since live steam instead of exhaust steam was now used for this purpose. More such controls have been installed since then.

Up to this time the original boilers still furnished all the steam used in the factory. In 1929, however, a spectacular boiler explosion in England alarmed the insurance company representatives who became concerned about the safety of the boilers because all had longitudinal lap seams in the drums. Strong arguments were advanced by the insurance company that some replacements be made. After suitable study, it was decided to scrap the 400-hp. boiler which had continuous lap seams on both sides of its drums and also the adjacent 275-hp. boiler which had been installed in 1899. In their places a 390-hp. cross drum, straight tube, Babcock and Wilcox boiler with a superheater and good for 200 lb. pressure was installed and was put into service at the end of 1930.

This boiler is shown in the photograph, Fig. 1. It is provided with a large furnace with 3 Bigelow-Liptak air cooled walls and an air cooled floor.

Adoption of Oil Firing Brings Many Advantages

After a study of the difficulty of handling coal in a restricted space, oil firing, using Woolley burners, was adopted but the furnace was built for pulverized coal and plans for coal handling were made for possible future adoption. As it was, however, the adoption of oil proved to be most fortunate for the price of oil tumbled during the next few years, and the comfort and cleanliness of oil burning was greatly appreciated and ease of operation improved. A 20,000-gallon oil tank and a pump were installed, beside a railroad siding a quarter of a mile distant and a pipe line built from there to two tanks of 17,000 gal. total capacity adjacent to the boiler room. This arrangement made possible the purchase of oil on a rail delivery basis.

Since the old boilers stood 15 ft. high and the new boilers 30 ft. high, extensive reconstruction of the boiler room was required. Advantage was taken of this to bring the floor up to street level and to provide an airy and well lighted room. Pains were also taken to obtain an arrangement both compact and convenient and also of good appearance. Since the plant is run by a single operator, a well equipped toilet room

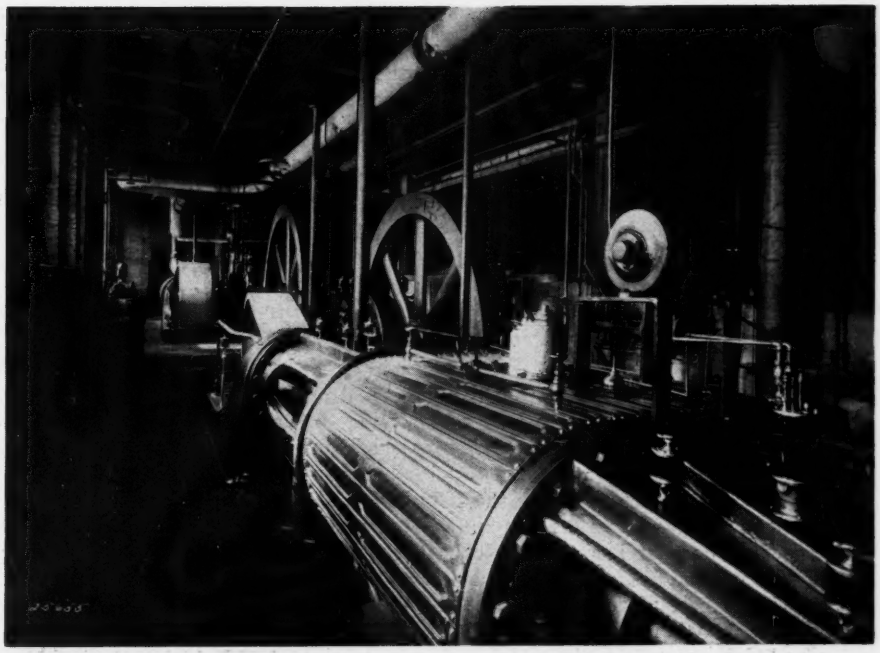


Fig. 5. The old engines driving rubber mills. These engines were replaced with synchronous motors in 1926.

was built on a balcony within sight of the pressure and water gages. The steam piping system was completely revised and all steam is now distributed from a header alongside of the boiler with all the valves in a row on a balcony and all distribution meters on a board directly below. It was an expensive job all told but the combined savings on fuel, labor and maintenance reduced the cost of steam by 30 per cent despite the increased fixed charges.

The installation of the new oil fired boiler with its 200 lb. pressure proved of immediate value in supplying steam for process heat. The two remaining old boilers installed in 1904 were only allowed 125 lb. pressure so every effort was made to keep the new boiler on the line as much as possible. It was found practicable to keep it going for 6 yr. with one shutdown in May and another in October, each of six days' duration. The durability of the air-cooled furnace and the effectiveness of the Hall system of water treatment were prime elements of this service record. Some slight trouble was experienced at first with the safety valves and blow-down valves developing leaks during the longer run but these troubles were soon eliminated.

The ease of operation and high reliability of this new boiler strongly influenced plans for the second boiler installed during the latter part of 1936 and the first part of 1937. It was decided to use the 1930 boiler for winter load and to install a 275 hp. boiler for summer load. A three boiler plan would, of course, have been more reliable but the economy of a two boiler arrangement makes it justifiable in a manufacturing plant where absolute continuity of service is not essential. The new boiler is rated to carry a 50 per cent increase in the existing summer load. If the winter load should increase in the same ratio, both boilers would be operated during the coldest months.

New Boiler Carries Summer Load

The 1930 or the winter load boiler has a capacity with present boilers of about 30,000 lb. per hr. which is just about the value of the winter load on the plant. Capacity can be easily increased to 36,000 lb. per hr. The new boiler, just installed and which will carry the summer load, is rated for 24,000 lb. per hr. It has a smaller furnace and it is expected will give better efficiency on low summer loads. Figured on the basis of steam flow meter readings and fuel consumption only, the 1930 boiler operates at a boiler efficiency of from 75 to 80 per cent.

The new boiler, which was placed in service April 24, 1937, is a Babcock and Wilcox, 3 drum, bent tube unit built for 275 lb. pressure and fitted with a superheater. As in the case of the first unit, the furnace is a Bigelow-Liptak with three sides, floor and upper part of the front wall air cooled. The furnace is only about half the size of the furnace on the 1930 boiler, but plans have been made for expanding and adapting this furnace for the use of either pulverized coal or stokers. Oil burners were again provided.

In the installation of this new unit, the only new auxiliary purchased was a forced draft fan driven by a four speed motor; otherwise the existing auxiliaries were considered adequate.

A view of this new boiler is shown in Fig. 3. This picture shows the air cooled front wall which employs only natural circulation. Air in the side and rear walls is drawn downward and under the floor into the forced draft fan. The temperature at the fan is about 260 deg. F. The forced draft fan with the hand wheel to operate the intake dampers by a worm gear mechanism can be seen at the left. Floor plates provide convenient access to the fan ducts.

The feed line flow indicator is on the wall above the fan. A corner of No. 1 boiler appears through the door on the left. The lower platform is shown above the feed line but it does not show very well. An intermediate stage just above head height breaks the ladders which give access to the lower platform.

The arrangement of ladders and railways is carefully worked out for safety. Five Diamond soot blowers are operated from this lower platform while the upper platform gives access to the upper drums. The stack damper is motor operated and controlled by a switch on the instrument panel. The boiler extends up through the old bunker floor. Stubs of the old beams appear in the left wall.

A feature of the boiler is the blowdown tank. Blowdown valves are operated from the floor and discharge directly into a vertical tank above the floor behind the boiler. A float indicator in the tank enables the operator to see exactly the amount of water blown out while he handles the valves.

The new boiler is operated from the same fuel oil system and the same feed water system supplying the 1930 unit. The forced draft fan is a Green Fuel Economizer unit driven by a 4-speed motor with belt connection. The forced draft fan for the 1930 boiler is a Sturtevant unit driven by a turbine and instead of the hand operated damper has a motor operated damper controlled from the boiler control board by push buttons. As in the case of the new boiler, the forced draft fan for the 1930 boiler is located directly in front of the boiler and delivers warm air (220-240 deg.) directly into a box around the burners.

Feedwater is treated by the Hall system, using sodium metaphosphate and caustic. This is pumped from a tank by a small motor driven pump and delivered to the feed lines just where they enter the boilers. The feedwater is heated to 214 deg. in an open Warren Webster heater by exhaust steam from the turbine driven auxiliaries. All auxiliaries deliver exhaust steam into the plant heating system and the feedwater heater is connected into this line. A Minneapolis Honeywell potentiometer type of controller regulates steam pressure in heater.

All make up is water that has previously been used for cooling in the factory. The water supply in overhead surge tanks is maintained at a desired level by a small centrifugal pump controlled by a float switch and drawing from underground tanks which are kept full and overflowing from various cooling water sources. Steam pressure of about 4 lb. is maintained on top of the overhead surge tanks by a Ruggles-Klingemann valve. This adds some heat and tends to move the water to the feedwater heater, there being little difference in level between the feedwater heater and the surge tanks.

Provision is made for by-passing either the feedwater heater or the surge tanks or using city water directly in case of emergency. The principle feed pump is a Warren 4-stage centrifugal unit driven by a Sturtevant turbine. Feedwater control has been effected manually by manipulating the turbine nozzles but is now effected by a Bailey regulating valve.

The total capacity of the two new boilers is about the same as the combined capacity of the four old boilers but the old boilers were never operated all at once except during the war when fuel ran over 50 per cent screenings.

Figure 4 shows the arrangement of the new boilers as compared with the old. The ratio of capacity to space (volume) occupied is not greatly different for the 1900 and 1930-36 installations, but the shift to half the ground area and twice the height has given a most welcome saving of ground floor area at the expense of far less valuable upper floor space. Thus the elimination of old No. 1 boiler made room for a new passage for internal transportation to the main manufacturing block. At the other end of the row, the elimination of old No. 4 boiler made room for a loading platform for the shipping department, a very badly needed facility.

As shown by the drawing, the new boiler plant occupied an area of only 3400 sq. ft. as compared with 6035 sq. ft. for the old arrangement. The full advantage of this smaller area can really be appreciated only by one who was familiar with the cramped shipping accommodations previously existing. The new driveway to the shipping platform removes most of the difficulties and, to paraphrase an old saying, is worth far more than its weight in boilers. At the present time the electrical load, which is entirely purchased, runs around 2000 kw.

To sum up, here is a factory with reasonably priced purchased power and with many disadvantages as regards power generation. The policy, therefore, has been to eliminate power generation and to provide steam for heat only by a compact and convenient installation, not cheap, but with low maintenance cost and with good economy of operation.

Principal Equipment in the New Boiler Installation at The Simplex Wire and Cable Co.

Boiler, Babcock & Wilcox Co., 3 Drum Stirling, Type H, 2740 sq. ft., 275 lb. pressure.
Superheater, Babcock & Wilcox, 70 deg. F.
Furnace, Bigelow Liptak air cooled.
Burners, Wooley, 2 units.
Forced draft fan, Green Fuel Economizer Co., belt driven by 4-speed motor.
Feedwater Regulator, Bailey Meter Co.
Feedwater Flow Indicator, Builders Iron Foundry.
Boiler Meter, Bailey Meter Co.
Blow-off Valves, The Edward Valve & Mfg. Co., Inc.
Safety Valves, Crosby Steam Gage & Valve Co.
Non-return Valves, The Chapman Valve and Mfg. Co., Inc.
Main Steam Valves, The Chapman Valve Mfg. Co., Inc.
Steam Gage, Consolidated Ashcroft Hancock Co., Inc.
Oil Gages, The Foxboro Co.
Draft Gage, Bailey Meter Co.
Steam Piping, welded by C. G. Bostwick Co.
Water Column, Yarnall-Waring.
Insulation, Johns-Manville.
Furnace, built by Frank E. Ross Co.
Consulting Engineers, Chas. T. Main.

Steel Point Installs 5000 kw. "Top"

In the list of principal equipment associated with the new installation at Steel Point Station presented in the July issue of Power Plant Engineering mention of several items was omitted. Four 2½ in. Yarway Steel Unit Tandem Blow-off valves supplied by Yarnall-Waring Co. and several 300 and 400 lb. Yarway Gun Pakt Expansion Joints should have been listed.

Power Development In Russia

Utilization of Low Grade Fuels and Improvement in Load Curves Result from Development Program Which Increased Power Consumption Almost 900 Percent in a Decade

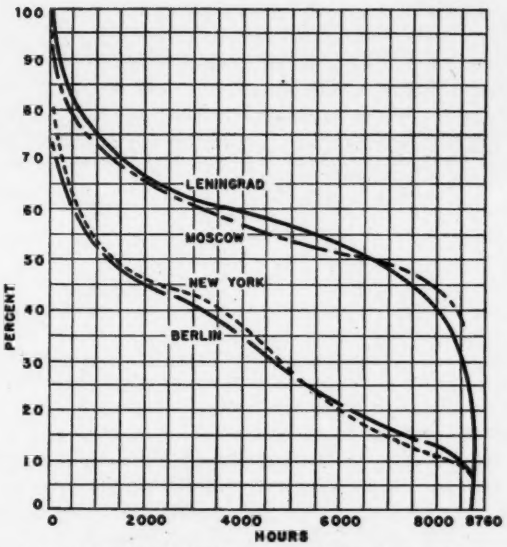


Fig. 1. Annual load duration curves of four large systems

BASICALLY the Russian electric power scheme is predicated on a single inter-regional system, directly related to the productive forces of the country and with complete coordination of primary steam and electric resources, industrial waste power and heating demands. The underlying factors are maximum reliability of the power supply, constancy of voltage and frequency, minimum overhead costs and of course conservation of natural resources.

In the decade from 1925 to 1935 the installed capacity was increased from 1,098,000 to 6,880,000 kw. and the consumption from 2,925 to 25,900 million kw-hr. Both of the 1925 figures represent an increase of about 15 per cent over the 1917 figures. Inasmuch as the usage increased some 885 per cent as compared to a capacity increase of but 627 per cent, it is apparent that the plant[1] or, if preferred, load factor, was greatly improved during this period.

Figure 3 shows daily load curves for three Russian systems and four European and American systems that resemble the Moscow and Leningrad systems from the standpoint of the classes of consumers and indicate how the curve has been flattened out. This is also reflected in the annual duration load curves of Fig. 1.

Daylight saving has been effective in reducing the evening peak and many American cities have had experience along this line. On the Moscow system, with a peak load of something over 320,000 kw., "Advancing the hands of the clock 1 hr. reduced the evening maximum by about 30,000 kw. in 1930-31." It is stated that the diagram also shows a substantial filling in of the night dip due to the growth of load in factories working three shifts but this increase does not seem to be any greater, if as great, as the average daily increase.

Staggering shifts and rest periods in various factories, shifting the day-off and in a number of cases scheduling the operation of apparatus consuming large amounts of electrical energy, provided the operation of this equipment was not limited to fixed hours by the nature of the technological process, were all employed to even out the load curve of electric power systems. Shift to the six day week had a material effect on evening up the Saturday, Sunday and weekday loads as shown by Fig. 2. The figure on the right would seem to indicate a considerable drop in the

[1]Plant or capacity factor is the ratio of the average load to the total rated capacity of the equipment supplying that load. As calculated in the book it is the annual output in kw-hr. divided by the rated station capacity times 8760, the hours in a year. For regional stations the weighted average installed capacity was used in the denominator and not the capacity at the end of the year, an important distinction when capacity is being increased rapidly. For other stations the arithmetical mean capacity at the beginning and end of the year was used. Load factor, often confused with plant factor, is the ratio of average power to the maximum demand. Inasmuch as the maximum demand is below the installed capacity the load factor will be higher than the plant factor. Figures given are taken from the book which indicates the source of the original data.

Although the U.S.S.R. was well represented at the Third World Power Conference, delegates took little active part in the scheduled program. Russian participation took the form of a 490 page book printed in English and distributed to members of the Conference.

This volume, prepared by the scientific staff of the Krzizhanovsky Power Institute of the Academy of Science of the U.S.S.R. at the request of the Committee for International Scientific and Technical Conferences, covers in detail the principal technical and economic problems of the nationwide electrification program under the title Electric Power Development in the U.S.S.R.

In the decade from 1925 to 1935 generating capacity was increased over 600 and power consumption almost 900 per cent with individual plant factors as high as 83.8 per cent, certainly super-base load operation. Entirely aside from political considerations, this electrification program was a real engineering accomplishment. The program called for the utilization of local low grade fuels and the lessons learned are particularly interesting in that they cover in many cases fuel which has not as yet been considered seriously in this country.

Another aspect of the problem as a whole, of particular interest to utilities, is the high load factors, not only of individual stations but of entire systems. Due to local load conditions these curves are of little more than academic interest in this country but are valuable in that they show the effects of changes which heretofore have been only hypothetical.

Data in this article, taken from the book, covers a very narrow aspect of these two problems which, after all, are but minor parts of the program as a whole. Transplanting the art of power generation to a little developed country involved difficulties of engineering, manufacturing and design, coordination of fuel resources, industrial and domestic needs. One of the major problems, as yet not entirely solved, was the coordination of hydro and steam power which involves changing the course of several major rivers in such a way as adequately to take care of climatic, transportation, fishery and agricultural needs of the nation, not only to maintain present conditions but to restore the Black and Caspian Seas and certain desert regions to more favorable conditions existing several centuries ago. In general this consists of diverting drainage from the southern watersheds eastward and that from the northern watersheds southward from the frozen tundras bordering the Arctic Sea.

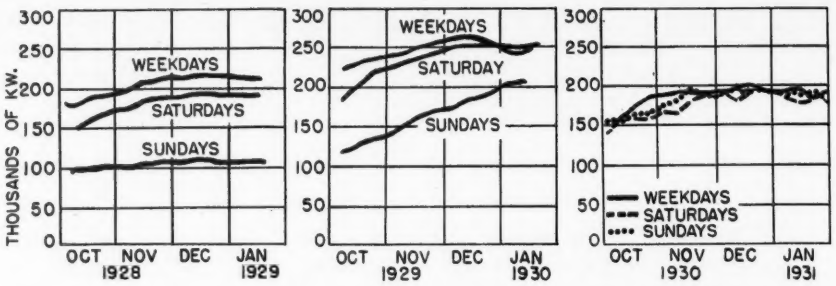


Fig. 2. Shift to the six day week had a material effect on the Moscow system load

total load from the previous year, although yearly figures taken from another curve showed that the load on the Moscow system increased about 30 per cent during the year in question.

On the Moscow system a mean annual plant factor[1] of 61.7 per cent was reached in 1935. This was higher than the 53.2 per cent (55 in 1933) for the Moscow system but lower than the 69.4 per cent on the Donetz Basin system. Corresponding mean annual load factors were 57.6, 57.8 and 75.3. The mean (apparently load factor) for all centralized electric output and all stations in the country was 53.1 and 45.8 per cent respectively. It is estimated that the approximately 540,000 kw. capacity of the Leningrad system would have needed an additional 842,000 kw. in 1935 if the 1913 plant factor had not been increased. Industrial station, 1936, plant factors for the newer stations range from 73 to 83.8, the highest being at the Zuyevka Station on the Donetz Basin system operating on anthracite culm. The next highest, 76.5, is the Orekhovo-Zuyevo station on the Moscow system

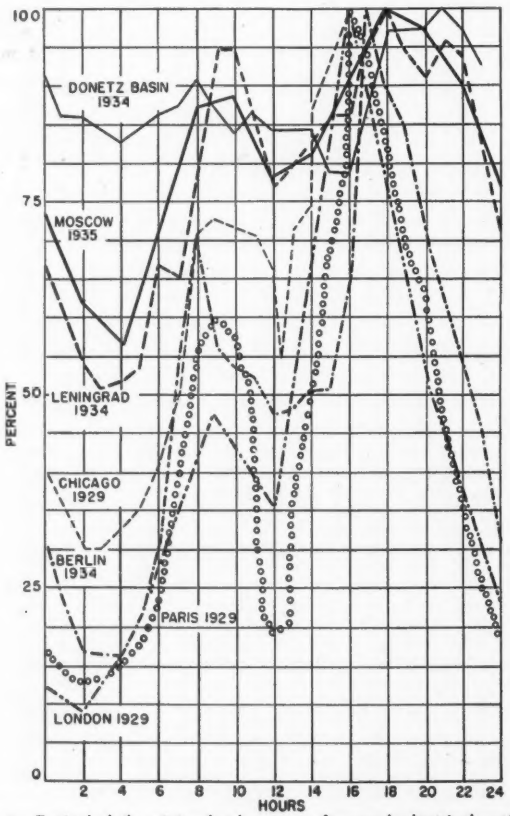


Fig. 3. Typical daily winter load curves of several electrical systems from different parts of the world

operating on peat. The installed capacity of these two stations is 200,000 and 12,600 kw. respectively.

Operation standards have also increased, transmission losses being reduced from 13.7 per cent in 1928 to 9.2 per cent in 1935, and station auxiliary power being cut from 7.37 to 6.87 per cent during the same period. These figures apparently refer to regional stations and not to all stations in the country. From 1925 to 1935 the mean weighted production cost per kw-hr. at the busbars dropped 24.9 and at the consumers' meters 32.2 per cent.

During the 10 yr. mentioned, the fuel consumption for regional stations dropped from 7070 to 4500 Kilocal (28,100 to 17,900 B.t.u.) per kw-hr., which is about on a par with the trend of public utility stations as a whole in the U. S. A. More significant from an engineering standpoint, however, is the fact that the greatest improvement was made in stations utilizing local fuel, peat, anthracite culm, Moscow slack and Ural coal.

It is recognized that much yet remains to be done: ". . . . in many respects Soviet electrical engineering has not yet caught up with the best foreign, and in particular with the American, standards of station operation, in the acquisition of new technique. This applies particularly to the standard of reliability of power supply, the time taken for repairs, the number of workers employed per 1000 kw. of installed capacity, and the production cost per kw-hr. Soviet power stations are still behind American stations in respect of automatic operation."

Transport and storage of these fuels were attended by many difficulties: spontaneous combustion (Moscow and Chelyabinsk coal, milled peat), low specific gravity (peat), large percentage of fines (anthracite culm) and freezing (Moscow and Chelyabinsk coal, milled peat). Difficulty was also encountered in developing methods of firing, owing to the high moisture, ash and sulphur content, and the low fusing temperature of the ash. Pulverization was eventually found to be universally applicable for low-grade coals, but this required selection of efficient systems of pulverization, complicated in some cases by high pyrites contents, development of drying methods, design of new types of furnaces, and special devices for handling the large quantity of ash and removing the ash and sulphur from the stack gases.

Of all local low-grade fuels, peat occupies a special position in the power economy of the U. S. S. R. and the aggregate capacity of regional stations using this fuel was 868,000 kw., with an output of 4,141,000,000 kw-hr., in 1935. Peat stations began with heat rates of 55,000 B.t.u. per kw-hr. but this has been reduced to less than 16,000 in several of the newer stations.

Review of various methods of bringing present plants up to modern standards of reliability and efficiency. Only through a careful survey of the existing plant to determine the efficiency and operating condition of the equipment and the future service requirements of the plant can the most desirable modernization program be planned

Modernization of Turbine Plants

By NORRIS D. GOVE
Westinghouse Electric Mfg. Co.

WITH POWER demands regularly reaching new peaks and with wear and tear remorselessly taking their toll of prime movers, it becomes increasingly necessary to modernize or replace antiquated equipment. The situation is not entirely painful, however, in that the required expenditures, if properly made, are certain to bring increased returns. An example of this is the case of a recent purchaser of a new turbine unit of medium size who figures that every month that elapses before starting up his unit costs him 36 cents per kilowatt of rating.

The engineer today has no doubt that he must increase the capacity of the efficient outfit of his system and he is having less difficulty than formerly in obtaining the necessary appropriations but with this done he is up against the problem of how to get the most benefit for his money, whether to build a new plant, extend an existing one or rehabilitate an old one. Each of these alternatives has many variables and the engineer cannot decide on one until each of the others has been analyzed in detail and the less desirable rejected. There seems to be no short cuts in this process and few general conclusions. Particularly must we avoid the conclusion that what seems best on A's system will be best on B's. The most similar systems differ enough to require a careful checking of all details. The writer makes no attempt to choose the best method of extension but will discuss some types of modernization of existing turbines which in general seems to be the least costly method of increasing output.

Replacement of Parts

The simplest modernization and usually the least beneficial from an efficiency standpoint is simple repair, the replacement of worn out parts so that the turbine may operate as reliably and perhaps as efficiently as when new. This may involve new nozzles, blades and seals, the building up of eroded parts and a general overhaul. Such repair work, however, is usually dictated by consideration of mechanical reliability since the increase in output and efficiency is usually small.

Some further extension of this gain may be made by taking advantage of the large factor of safety in many turbine units to increase the capacity. This may involve nothing more than oversize nozzles or it may require blading of stronger materials, a rebuilt condenser and a generator re-wind. When the requirements are not excessive this may be a desirable way to increase capacity; the only objections being the encroachment (often not serious) on factors of safety and the lack of any increase in efficiency. Rebuilding for any great increase in efficiency over the original usually entails a prohibitive cost although an exception to this rule will be noted later.

Another possibility in modernization consists of rebuilding idle 25 cycle units for 60 cycle operation. In this case the work on the turbine may vary from a simple change of the governor gears to a complete rebuilding. It goes without saying, of course, that the generator must be completely rebuilt. In addition to the cost of the speed change there is also the cost of necessary repairs and work which may be required for any increase in rating.

There comes to mind the case of one large utility which has embarked on an extensive course of rehabilitation of this type. In this case the 25 cycle units are being completely rebuilt for higher speed, increased rating and modern efficiency at a cost which is about two thirds the price of new units. It is quite possible, however, that the extent of this modernization is partly justified by high land value in that locality which militates against a new plant and by the imminent superposition program which insures a high use factor for the rebuilt machines. These considerations might not prevail in another system.

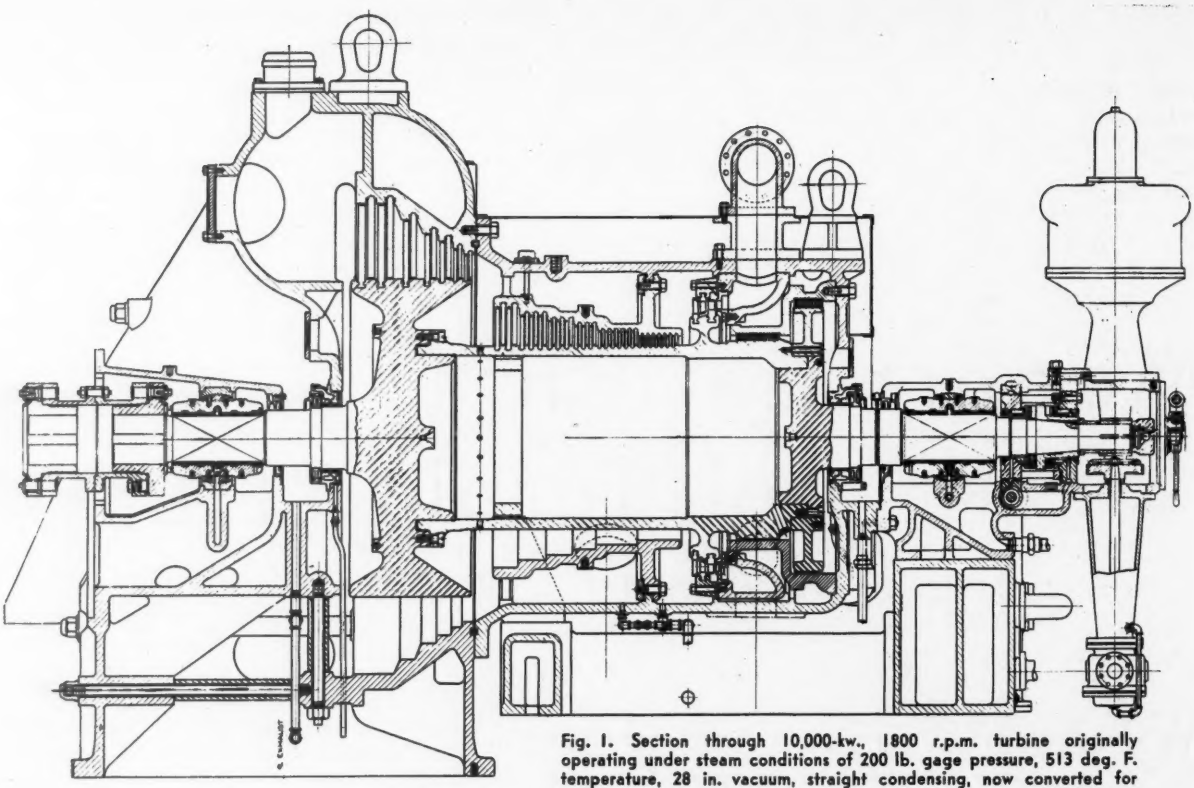


Fig. 1. Section through 10,000-kw., 1800 r.p.m. turbine originally operating under steam conditions of 200 lb. gage pressure, 513 deg. F. temperature, 28 in. vacuum, straight condensing, now converted for 335 lb. pressure, 600 deg. F. temperature, 28 in. vacuum, feed-heating

Steam Cycle Changes

So far the discussion has been limited to rebuilding without change to the steam cycle and where the improvement in thermal efficiency is so small as to justify relatively little increase in use. The big decreases in heat rate of the past 20 yr. have been due to the improvement in the steam cycle. This means in particular increases in pressure, temperature and vacuum and the application of regenerative feed-heating. It follows then that modernization, to be really

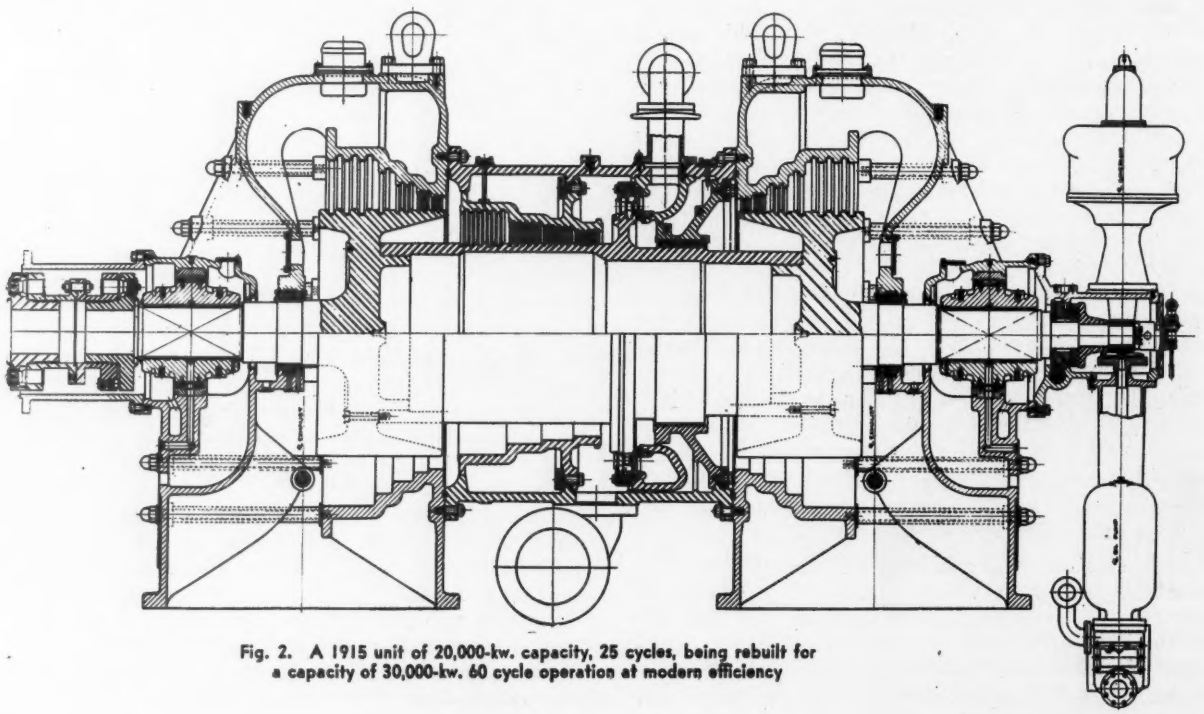


Fig. 2. A 1915 unit of 20,000-kw. capacity, 25 cycles, being rebuilt for a capacity of 30,000-kw. 60 cycle operation at modern efficiency

effective, must incorporate these factors to the greatest possible extent.

Increases in pressure and temperature can be easily made up to the limit set by existing parts or parts which it is desirable to retain. In the case of straight reaction turbines with cast-iron parts, the limit is about 200 lb. at 500 deg. In the case of the Curtis-reaction or Curtis-rateau designs where high pressure is limited to comparatively small parts, these parts can be replaced by steel and the pressure increased to 250 or 400 lb. with temperatures of 600 to 700 deg. depending somewhat on the conditions both mechanical or thermal farther down in the expansion. Similarly a more modern 400-lb. machine can sometimes be raised to the 600-lb. level without excessive cost. At the other end of the cycle, sometimes improved vacuum can be obtained by a redistribution of the steam lanes and improved air removal apparatus. When these extensions in cycle take place at the time of a necessary mechanical rebuilding the cost ascribable to the cyclic improvement is small compared with the benefits obtained.

Regenerative feed-heating has been applied to many old units with excellent results. Most turbines built before the general adoption of this cycle had openings which can be adapted to bleeding while many more modern units had more than the required number of openings permitting an extension of the practice. Occasionally additional openings can be provided at somewhat greater expense. Generally larger inlet nozzles can be installed without great difficulty and, if other factors permit an increased rating, it is justified by the reduced load per hour on the condensing equipment. The use of feed-heating reduces the heat rate 4 to 13 per cent depending on the extent used and the initial pressure, the larger figure applying to multi-stage heating and high boiler pressures.

It will be observed that these cyclic improvements while they increase the plant efficiency remarkably, permit only moderate, if any, increase in capacity. They are of value from a capacity viewpoint mainly in that they may change a unit as a plant from standby quality into a higher classification. Superposition goes farther than this. It improves the steam cycle to the limits of modern practice, provides 30 to 100 per cent increase in plant capacity without any increase in condensing facilities and usually elevates the plant to the base load level. Superposition leaves to existing turbines their part of the expansion, namely from 150 to 400 lb. initial down to condenser pressure, and "tops" the old cycle with a new non-condensing unit which exhausts into the older turbines. Recently the most favored throttle conditions for superposition turbines have been about 1200 lb. per sq. in. gage—900 deg. F. total temperature which in a complete new installation would yield a turbine heat rate of 9000 to 9500 B.t.u. per kw-hr. in ordinary sizes, with the old low pressure turbines and condensing equipment used, the corresponding rates are 9500 to 10,500 B.t.u. per kw-hr., depending on the rating and the efficiency of the original units. This superposition, with an outlay per unit of increased capacity less than that for a corresponding unit, rejuvenates the whole plant.

Engineers usually think of superposition as being the last step in modernization. Another step which may not be taken for 10, 20, or 30 yr. is the replacement of the low pressure turbines which are not being "topped". The higher efficiency of the new low pressure turbines will increase plant capacity and efficiency without change to the high pressure element.

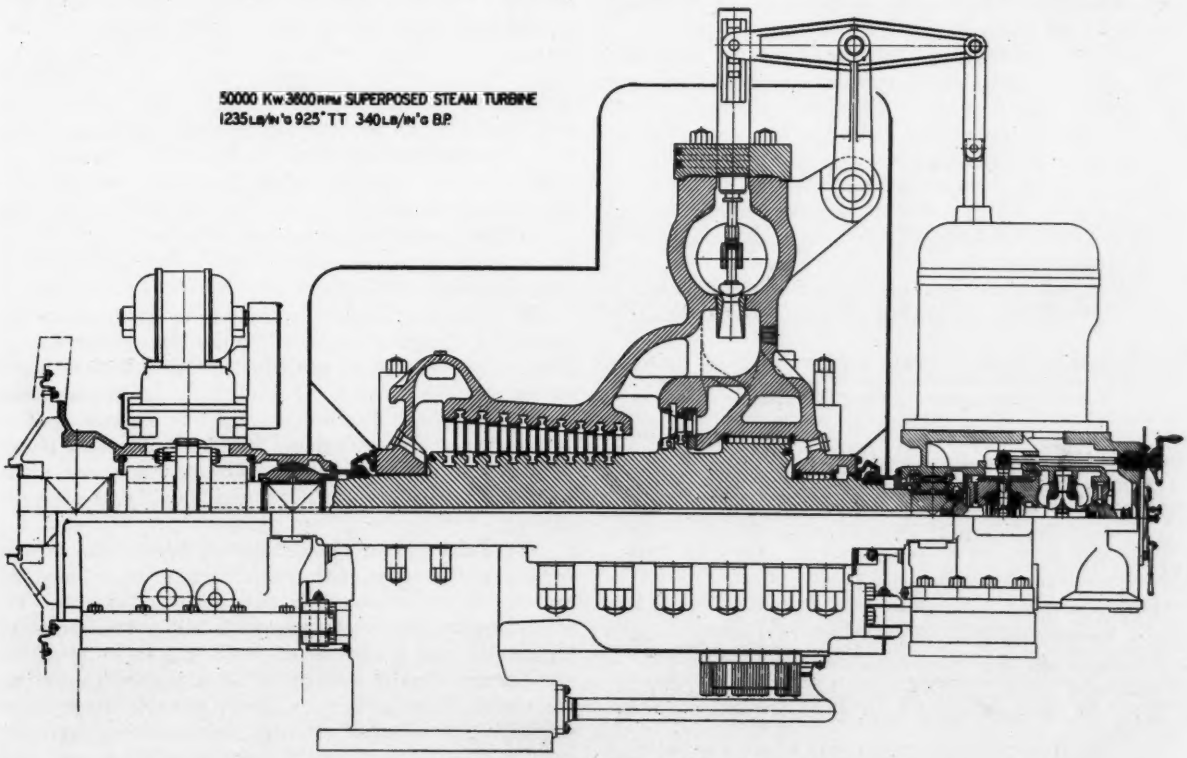


Fig. 3. Superposition turbine of modern design

Prevention of FURNACE EXPLOSIONS *

By E. G. Bailey,
President, Bailey Meter Co.,
Vice-President, The Babcock & Wilcox Co.

FURNACE EXPLOSIONS persist in spite of the attention and effort by everyone concerned to prevent them. It seems to be a trait in the human race to feel a sense of security in whatever one does for one's self so that it is often difficult to impress another with the need for ample care and precaution until they have experienced an accident or near accident. It would be safer if everyone would learn his lesson well from second hand experiences and from a knowledge of combustion limits.

From this viewpoint it is best that each furnace explosion be thoroughly investigated, the cause determined and all facts given sufficient publicity to properly guide those responsible for design, inspection and operation of similar equipment. No furnace and no kind of fuel is immune from some possible explosion hazard. They occur in house furnaces as well as in power boiler furnaces. Explosions are more prevalent in gas fired furnaces, probably because gas is the easiest and simplest fuel to burn and everyone knows, or thinks he knows, all about it.

To completely prevent furnace explosions there are three separate and distinct functions to be carried out. First, provide and properly install suitable equipment. Second, prepare complete and accurate operating instructions, anticipating all possible emergencies. Third, operate the furnace in accordance with the instructions, but first give the operator a complete understanding of all the equipment and the reasons behind every item of the instructions.

The greatest number of furnace explosions occur when starting up or lighting off. This is particularly true with gas and pulverized coal though less likely with oil. The next prevalent condition is a stop or decrease of fuel feed, causing loss of ignition, followed by a resumption of fuel without repeating the proper lighting cycle, although cooled furnace loses its temperature quickly. A refractory furnace may retain sufficient heat for a short time to reignite the fuel, but delayed ignition is hazardous. In every case the fuel should be shut off and relighted in the regular way as any deliberate attempt to reignite the fuel from residual heat of the furnace is untenable.

Another condition which may result in an explosion is a decrease in the air supply to an extent where considerable unburned fuel accumulates in the furnace and flues. This may ignite when the proper fuel-air ratio is restored, or, if the change is to a condition of slightly abnormal excess air. This may occur with oil or pulverized coal more readily than with gas, but explosions from this cause sometimes occur even in hand or stoker fired furnaces.

Furnace explosions cannot occur upon lighting if: 1, the furnace is purged of all fuel; 2, ample torch flame is properly applied to each burner before fuel is turned on to each burner in succession; 3, air velocity at each burner is kept low enough to prevent blowing out the flame; 4, fuel is supplied in a sufficiently rich mixture to immediately ignite from the torch; 5, after ignition is established, the correct proportion of fuel and air is maintained throughout the entire time furnace is in operation, and, if the furnace is operated at a high enough rate to maintain stable ignition.

This seems and is simple, but quantities and proportions must be established and known. Emergencies caused by power failure, fuel failure, wet coal, water in the oil, etc., must be provided for. Fans, feeders, and fuel supply should be started in the proper sequence and they should be properly interlocked, so that when one trips out certain others will also stop. There should be enough instruments, gages and meters installed so that the operator can know exactly what is taking place. Whether or not the furnace is equipped with automatic combustion control, the operation of fans, dampers, and fuel supply should be controllable from accessible places on the operating floor, preferably from a meter panel. From this operating station the operator should be able to see the flame, or a reflection of it at all times when the furnace is operating.

While the source of fuel supply to the furnace should be protected against leakage into the furnace it is never safe to light off gas, oil or pulverized coal without first scavenging the furnace for 5 min. To make sure that the air is actually flowing through the furnace, an air flow meter or its equivalent, a differential draft gage, should be used, as damper position, fan speed or a single draft reading are not positive evidence of scavenging.

There should be a good sustained torch flame of gas or oil at each burner as they are lit in turn. Oil torches burning No. 3 Furnace Oil at the rate or 250 to 300 lb. per hr. are ample. Gas torches with only partial premixing should give a luminous flame 4 to 8 ft. long. Only one burner should be lighted at a time. The torch flame should be properly directed parallel to or at a slightly converging angle with the incoming fuel and ignition should start within a period of 5 sec., and not

Table I. Explosive Mixtures of Gases and Vapor. Lower and higher approximate limits of inflammability in air at ordinary temperature and pressure given in percent by volume.

Gas or Vapor	Lower	Higher	Ignition Temp. °F.
Hydrogen	4.1	74.	1070-1090
Carbon Monoxide	12.5	74.	1150-1210
Methane	5.3	14.	1200
Ethane	3.2	12.5	....
Propane	2.4	9.5	....
Benzene	1.4	7.0	1330
Gasoline	1.4	6.0	....
*Oil Gas	6.	13.4	....
*Natural Gas	4.8	13.5	....
*Illuminating Gas	5.3	31.	1200-1380
*Water Gas	6 to 9	55 to 70	....
*Blast Furnace Gas	35.	74.	....
*Producer Gas	36.	80.	....

*Variable with exact composition.

Data from U. S. Bureau of Mines Bulletin 279, Technical Paper 140, 396; Technical Data on Fuel by H. M. Spiers; The Making, Shaping and Drawing of Steel by Carnegie Steel Co.

* A paper presented before the Eleventh Annual Meeting of the National Board of Boiler & Pressure Vessel Inspectors.

be delayed more than 10 sec. The flame should be stable within 30 to 40 sec. from the delivery of the first fuel to the burner.

Fuel should be a rich mixture, that is, with less than its normal air, equivalent to using the choke when starting a cold automobile engine. This is not always easily done with all forms of pulverized coal equipment. Where air must be put through a pulverizer as soon as coal is fed to it there is a surplus of air or a lean mixture for a considerable period before enough coal can be pulverized to form a mixture sufficiently rich to ignite. When ignition takes place there is a puff or a more or less severe explosion. In case the coal is not rich enough to ignite in a reasonable time the operator should cut off the coal feed (and also the torch), scavenge the furnace and try again. Sometimes several failures occur, resulting in a hazardous condition from a considerable quantity of unburned coal lodging on the boiler tubes or elsewhere, this may be shaken loose when an ignition does take place with a puff and add sufficient fuel in suspension to make a major secondary explosion.

Table II. Explosive Properties of Coal Dust. Pressure of explosion given for ignition at 2200 deg. F.

Source of Coal	Rank of Coal	Volatile per cent	App. Ign. Temp. °F.	Pressure lb. per sq. in.
N. Dakota	Lignite	41	1380	17
Utah	Sub. Bituminous	44	1660	20
Penna.	Bituminous	33	1660	14
Alabama	Bituminous	26	1730	11
W. Va.	Semi Bituminous	17	1830	6

Coal dust is said to be dangerous when one cannot see a miner's lamp (one candle power) at 6 ft. distance. Dust is not dangerous when an ordinary electric light can be seen at 40 or 50 ft.

Data from U. S. Bureau of Mines Technical Paper 141. Chemistry & Industry July 31, 1931. Dust Explosions, David J. Price.

A pound of Pa. Bit. coal on coking gives off 0.174 lb. of gas (5.8 cu. ft.) and 0.086 lb. of tar, benzol, naphtha, etc., leaving a coke residue of 0.76 lb. Distillation takes place at from 500 to 2000 deg. F.

After stable ignition has been obtained the torches should be cut off and the fuel-air ratio should be properly maintained for purposes of efficiency as well as safety. Flue gas analysis apparatus or steam flow-air flow meters are available for this purpose. Automatic combustion control has also been brought to a state of reliability. Meters and instruments can only indicate and record conditions they cannot of themselves correct them. Automatic combustion control can only regulate air and fuel within the ranges in which they are available. If a fan trips out, decreasing the air supply, the control may not be able to restart the fan, or, if fuel fails to reach the burner it remains for the operator or the automatic control to get fuel from other sources or shut the furnace down.

Failure of air supply for combustion should immediately shut off the fuel. Failure of fuel supply or a loss of ignition need not cut off the air supply, but the fuel should be immediately cut off to prevent unignited fuel entering the furnace in case the supply is resumed. With gas or oil, there should be a low pressure cut out. The fuel should not be allowed to come on except in accordance with the regular lighting up cycle. A source of flame failure when burning oil is sometimes caused by water in the oil. There is a definite hazard where this happens and oil flow resumes after a short interval but does not reignite promptly. Gas formed from oil discharged into a hot furnace is hazardous as it may ignite from hot brickwork. A detector, such as a photo cell, should instantly shut off the fuel line upon flame failure from any cause.

With pulverized coal a flame failure from any cause should shut down the pulverizer and its fan or otherwise stop coal from entering the furnace. A power failure is simple in that the motor will not restart on resumption of power. If fuel failure is due to coal hanging up before reaching the pulverizer, it is equivalent to water in oil, and a flame detector may be the safest protection.

One of the greatest hazards with any fuel is a short interruption of the fuel alone and then a resumption with delayed ignition. One reason is that in a hot furnace, especially where it is slightly below the ignition temperature of the fuel, there is a wider range in the explosive limits, and if the fuel reaches a hot spot a major explosion may occur with either a leaner or a richer mixture than would explode in a cold furnace as when first lighting off.

Water cooled furnaces are an added safety in that they cool the furnace so quickly after loss of ignition that reignition is less likely than from a refractory furnace, or if there is ignition the lower temperature of the furnace will narrow the explosion range as just explained. Pulverized coal or oil entering a furnace which is hot, but below the ignition temperature, may produce a hazard by distilling gas, and diffusing it more evenly throughout the furnace than would either the coal in pulverized form or oil in atomized form. Oil vapor may condense on the heating surface or walls, reevaporate and explode after a normal lighting up has been made. Scavenging the furnace does not remove condensed oil vapor effectively, and may not remove all of the pulverized coal which may be deposited.

This will indicate why lighting torches should be cut off as soon as sustained ignition is attained and the operator is engaged in other duties. A burning torch may cause an explosion which would not otherwise occur when there is a loss of ignition of the fuel itself, followed by a resumption which may not be sufficiently rich or close to the torch to light properly and promptly. The shut off valve to each gas or oil torch should be close enough so it will extinguish promptly when turned off without dribbling oil into the furnace or have a weak lingering gas flame. It is recognized that a continuous torch or pilot light is proper for house heating and other small furnaces. Gas torches, as well as gas burners, should always be piped up so that they vent safely to atmosphere, preferably through the roof, when supply valves are in the "off" position. This is to remove the possibility of a leaky valve allowing gas to enter the furnace.

Table III. Explosive Mixture Data applying to Pennsylvania Bituminous Coal from Table II.

Ounces of coal per cu.ft. air	Cu. Ft. air per lb. coal	Excess Air complete combustion
0.032	500	265[1]
0.05	320	135[2]
0.118	136	zero[3]

[1]Lower exp. limit ideal condition.
[2]Lower exp. limit probable in furnaces when cold and lighting off.
[3]Theo. mixture for complete combustion.
Data from U. S. Bureau of Mines Report of Investigations 3132.

The subject of explosion doors is perhaps the most debatable one in connection with explosions. There is a great deal to be said both for and against explosion

doors. A slight puff or light explosion will do no damage even if there is not an explosion door on the furnace, while a heavy explosion will do damage regardless of any explosion doors which are feasible. Therefore, the use of explosion doors is of benefit only for intermediate cases.

High duty furnaces with the prevailing use of water cooled walls make it more difficult to add explosion doors than it has in the past. It is believed that the water cooled furnace has a tendency to minimize explosions as previously explained, and, with proper buckstays it is capable of being built so that it will withstand a greater explosion without damage.

As to the possible pressure available in a coal dust explosion, the Bureau of Mines calculated that in a constant volume with no loss of heat, a temperature of 4978 deg. F. and a pressure of 142 lb. per sq. in. may theoretically be obtained. In a closed vessel due to imperfect mixture it is seldom that 20 lb. per sq. in. is exceeded, and special care must be taken to get a sufficiently good mixture and properly timed ignition to reach 40 lb. per sq. in. except in mines or long galleries where a velocity wave effect is obtained. A restricted hydrogen explosion may produce 300 lb. per sq. in.

In boiler furnaces, however, there is seldom a case where the mixture of fuel and air is at its maximum explosion power, and seldom is the entire furnace volume filled, so that an explosion may be rated as a certain percentage of its possible maximum. There is also the question of heat being absorbed from the flame while propagating, and this diminishes the final pressure. There is also expansion into the parts of the furnace which are not permeated with the explosive medium. The stack constitutes a large area venting to the atmosphere. There is also leakage of gases of combustion through doors, cracks, etc.

It is obvious that furnaces cannot be built to withstand very high pressure, nor has history indicated it necessary to do so. It is believed, however, that pressures of 36 lb. per sq. ft. with not over 18,000 lb. stress in steel buckstay members should be provided for. Experience over a number of years has shown that with proper precautions in lighting and operating it is exceptional that any damage whatsoever will be done to a water cooled furnace fitted with buckstays designed for this pressure. Furnaces can be designed to resist still higher pressures perhaps better than to add any large area as explosion doors.

Another feature of explosive hazards is the accumulation of dust from incompletely burned oil or coal back through the boiler setting passes or soot pockets. Such material should be blown out while the boiler is operating and the gases going through the boiler and flues have a low percentage of oxygen. If, after a boiler is shut down and some fire is smoldering in such localities, the soot blower is turned on to get rid of it, the stirring up of the combustible dust may cause ignition and a serious explosion, damaging flues, or even the boiler setting proper. To prevent hazard from this cause, a complete schedule of soot blowing should be worked out and carefully followed.

While indicating instruments are often ample for the guidance of a careful operator, it is best to have the more essential features permanently recorded. These records aid the operator in checking any changes which have taken place, or any variations in output, relationship, etc. Records are also extremely useful in ascertaining the cause of explosions which occur.

It is believed that the use of automatic mechanisms and safety devices can be carried to a greater extent than has yet been done, even though it is recognized that there is sometimes opposition to such devices where they themselves may cause more trouble than they are preventing. There is, however, a very definite improvement in all types of automatic control and equipment through the concentration of efforts of many manufacturers and users, so that its reliability is improving year by year. A great deal of this equipment is much more trustworthy than is the human factor when left alone to judge combustion conditions, air supply and act with sufficient speed to prevent an explosion in case of power failure or unexpected circumstances.

A paper read at the annual meeting of The American Society of Mechanical Engineers on Steamotive, December, 1936, described a high pressure boiler which, with forced circulation and the very minimum of water requires complete automatic control in proportioning fuel, air and water to the demand for load.

This equipment is completely automatic in lighting up, and has flame detectors and safety devices of all kinds, so that it is substantially fool-proof in every respect. This equipment was put through a series of tests of the most rigid character, and no furnace puff ever occurred of sufficient magnitude to blow out a metal relief plate of limited strength. This equipment, and others similar to it, are in successful operation.

Tables I, II and III give for ready reference certain data, taken from recognized sources, which may be helpful in arriving at solutions for explosions. For instance, if an explosion has occurred in an oil fired furnace it is noted that a relatively small percentage of oil gas, six per cent, will make an explosive mixture. If it is evident that conditions existed whereby oil gas vapor could have been present, that cause is within the range of possibility.

In another instance an explosion in a pulverized coal fired furnace may be investigated as to whether it was a dust explosion; an explosion of gas from the lighting torches, or an explosion of gas distilled from coal which settled onto the floor of the furnace. If not more than 10 lb. of coke can be found, there would not likely have been more than 3 or 4 lb. of gas generated, approximately 120 cu. ft. of coal gas, which in a furnace of 10,000 cu. ft. would be only slightly over 1 per cent mixture with the damper closed and the furnace tight. The lower explosive limit for such gas is about 5 per cent, so this cause would seem improbable, especially so as the furnace would have to have been at near 1900 deg. F. to have distilled this much gas from the coal.

Another point to remember is that when approaching the ignition temperature of a gas or vapor the higher explosive limit may be materially increased and the lower limit only slightly reduced. Furnace explosions are often surrounded with many puzzling circumstances, but if a complete record or knowledge of all contributory factors is available the cause is usually satisfactorily determined. If the operator had available and intelligently used this same information before the explosion it most probably would have been prevented.

AUTOMATIC DIESEL CONTROLS

Fundamental requirements and necessary flexibility to meet requirements of high speed Diesels met by automatic starting system applicable to many engines of this type now on the market employing standard battery operated starting equipment

By HAROLD E. HILL,
New York City

RECOGNIZED as a dependable and economical source of power, the Diesel engine has up until comparatively recent times been limited in its application to larger power plants. With the advent of the light weight, high speed Diesel engine, however, this convenient form of low cost power has been made available to even the smallest of power users. It has been handicapped in many instances, however, by the fact that an attendant was needed for starting and stopping, whereas many applications require the prime mover to be fully automatic in its operation.

Recent enactment of regulations pertaining to marine equipment requires the installation of an automatically controlled Diesel generating unit to be installed aboard certain passenger carrying vessels. This generator unit must be so arranged that if the main source of power aboard the ship fails, the generator will start automatically within a pre-determined time and furnish emergency lighting and power for the ship's communication equipment. Legislation in some states also requires that automatically controlled emergency lighting facilities be installed in certain public buildings to supply exit lighting should the main source of electrical energy fail. Municipal and private water pumping systems, as well as disposal plants, require pumps which shall start and stop automatically in accordance with either water pressure or water level variations. Refrigerating and cold storage plants require automatically controlled refrigerant compressors, which maintain temperatures within definite limits.

The above are only a few of the applications open to the light weight, high speed Diesel engines of the automatically controlled type. Such an engine could be readily applied to new as well as existing projects, which would otherwise of necessity be electric motor driven. A Diesel engine of the light weight type running at higher speed, and automatically controlled has therefore practically unlimited possibilities in the industrial field.

In order that it may be automatically controlled a Diesel engine must be fitted with apparatus to accomplish the following:

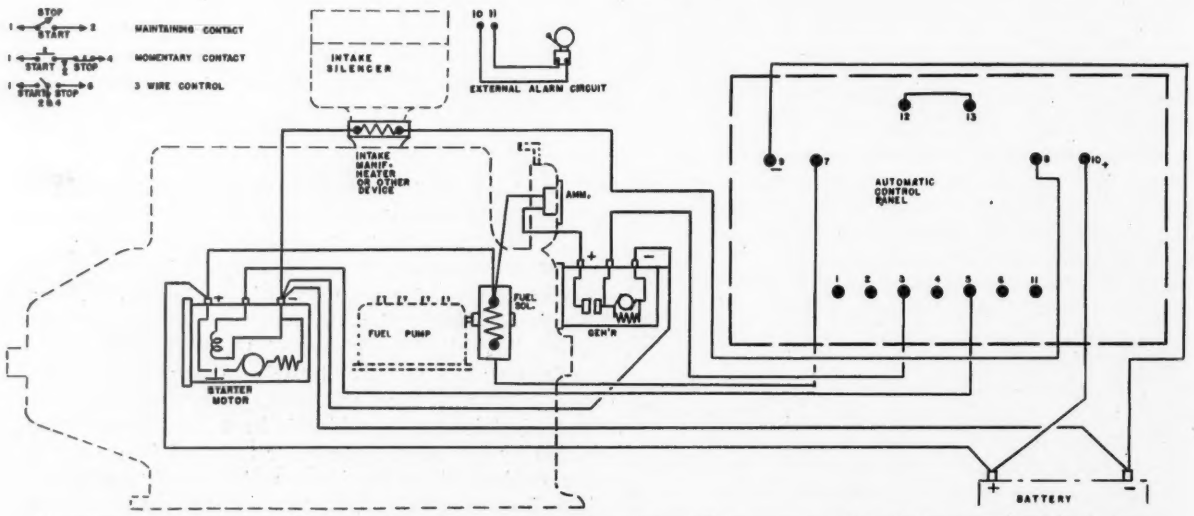
A. To crank the engine until combustion takes place.
B. To disconnect the starting mechanism after the cranking period.
C. To turn the fuel supply on and off.
D. To insure prompt combustion. This may be facilitated by means of either a variable compression ratio device, or, a means of introducing additional heat into the combustion chamber during the starting cycle.
E. A means of limiting the cranking period to protect the starting equipment should the fuel supply become depleted.
F. To protect the starting equipment from damage due to rapid fluctuation of the load circuit which might cause the starting mechanism to be thrown rapidly on and off.

With these and other problems in mind, the writer has made available an automatic control unit, shown diagrammatically by the accompanying drawing which is applicable to most of the high speed Diesel engines on the market at the present time. Most of these engines employ an automatic type battery operated electric starter, which is kept in a charged condition by means of a generator mounted integral with the engine. Some engines employ a glow plug for introducing additional heat during the starting cycle. Other engines are fitted with a solenoid operated compression ratio changing device to accomplish quick starting. This automatic control unit provides the means for operating any of the necessary auxiliary heat introducing mediums. Means are also provided to operate the fuel oil supply for starting and stopping the engine. It is so arranged that it may be operated by a single pole, 2 wire, or a 3 wire pilot device, such as a thermostat, float switch, pressure switch, relay or any other desired means, by making the proper connections on the panel. The starting motor pinion gear and the flywheel ring gear are protected against damage through a rapidly fluctuating load, the natural tendency of which would be to throw the starter rapidly on and off with potential serious damage to the gear. The automatic controller is so arranged that it will respond only after the controlling circuit has been sustained for a definite period of time.

Provision is also made for failure of the starting motor pinion to engage with the flywheel ring gear. Should this condition occur, the starting motor is de-energized temporarily but immediately is re-energized for another attempt. This procedure is repeated until after several unsuccessful attempts, the entire mechanism disconnects itself from the battery and a red pilot light is lighted. This red pilot light also gives indications if the engine has been shut down automatically for lack of fuel oil, shortage of lubricating oil supply, or excessively high cooling water temperature.

Under ordinary normal operating conditions a green pilot light indicates that the plant is functioning properly, while a failure of any part of the installation due to any cause whatsoever will cause a red pilot light to indicate that trouble is present and this pilot light will continue burning until the cause of the trouble is investigated and the light manually reset. Provision is also made for operating a multiplicity of Diesel engine power units in parallel or in any desired sequence. If during the normal sequence of operation any one of the units became disabled or inoperative, the automatic control unit would isolate the engine from the sequence, and substitute the next unit in line. This entire control equipment is contained in a sheet metal cabinet about 12 in. on a side, and weighs only about 50 lb.

It is obvious that the availability of this automatic controller for use with Diesel engines opens up a new field of application to this economical source of power. As an emergency standy lighting plant, the automatically controlled Diesel unit has no equal, especially when, as it can be, brought into operation within an elapsed time of 10 sec. or less. The Diesel driven generator can also be used as an automatic peak load unit to start automatically and parallel itself with the base load plant. It is also useful in cases where energy is being purchased on an off peak basis, with a penalty for exceeding a certain amount. In an application of this type a load relay responds, when the load had reached within a few per cent of the permissible maximum, to start the Diesel and hold it in readiness to take over the excess demand of the system. Automatically controlled Diesel engines can be applied to good advantage to the water pumping station, as well as to the sewerage disposal plant. In these cases the engine is controlled automatically by means of a liquid level controlling device, or a pressure regulator working within the desired limits. Several installations of this type have been made and are working to the owners' complete satisfaction. Many other applications for the automatically controlled Diesel engines will present themselves to those interested in this type of equipment.



Diagrammatic arrangement of automatic starting system for Diesel engines which incorporates all the features mentioned in the text.

This equipment starts the engine in the following sequence. When the pilot circuit or the starting switch is closed, the heater and fuel solenoid are energized. Approx. 20 sec. later the starter cranks the engine three times for periods of 10 sec. If the engine starts during one of these cranking periods, everything except the fuel solenoid becomes de-energized. If the engine does not start after the third cranking, the controller disconnects the battery and lights a pilot lamp indicating failure to start. If the engine stops after having properly started, due to lack of fuel oil or any of several other reasons, the control will again disconnect everything from the line and light the pilot lamp. If due to an intermittent contact of the starting button, the timing motor advances to a point where it would take less than 10 sec. between the energizing of the heater and the starter, the control will automatically reset itself to the original starting position.

There are two switches on the controller. One marked "on-off" and the other marked "manual-automatic." With the switch in the off position the engine cannot be started. If the engine is running and this switch is turned to the off position, the engine will stop. With the switch in the on position the engine may be started manually by turning the other switch to the manual position.

Turning this switch to the automatic position will permit the starting of the engine depending upon the connections to the four terminals marked 1, 2, 4 and 6. These four terminals permit the installation of 3 different types of starting and stopping pilot devices.

FIRST, maintaining contact control. In this case the pilot device closes a circuit to start the engine. The engine runs as long as this circuit is closed and stops as soon as it is opened. This may among others be a float switch, a pressure switch, a thermostat, a time clock or a toggle switch installed at a remote point. The two wires from these devices are connected to terminals 1 and 2.

SECOND, momentary contact control. Momentarily closing a circuit starts the engine and momentarily opening it stops the engine. In this case the starting button is connected to terminals 1 and 2 and the stopping button to terminals 2 and 4.

THIRD, 3-wire control. This is often used with thermostats. Momentarily closing one circuit starts the engine and momentarily closing another one stops it. This is accomplished by connecting terminals 2 and 4 together. Closing a circuit from this combination to terminal 1 will start the engine and closing a circuit from this combination to 6 will stop the engine.

Terminals 12 and 13 permit the installation of such safety devices as lubricating oil pressure switches, cooling water thermostats, etc. In case this circuit is opened after the engine is running the engine will stop, but if the condition corrects itself the engine will not start again automatically. Inasmuch as the pilot lamp will light, an attendant will be able to see at once that the engine has stopped from some abnormal reason and permit correction of the trouble before starting the engine. In the event that this protection is not required, these terminals may be permanently short circuited.

Lighting of the red pilot lamp is always an indication of trouble and it requires manual resetting. It may be advantageous to indicate at a remote point that trouble has developed. This may be done by a lamp, alarm bell or relay connected between terminal 11 and the positive side of the battery.

Diesel Lubrication —a new approach

PART II. Lubricant selection must be based on a compromise between conflicting requirements and services

By E. H. HILLMAN
Standard Oil Co. (Ind.)
Chicago, Ill.

SOME MAY be surprised at the emphasis placed on temperature as it affects lubrication. It is in fact the number one consideration in the present state of the lubrication art. Such items as "friction reduction," "rate of wear," "corrosiveness," "film strength," "cold test," or "cleanliness" lend themselves to exact measurement and control, hence are not important as used in most Diesel lubricating oil discussions. Conventional oils are satisfactory in these respects or differ only slightly. Of course, the body or viscosity must suit the operating temperatures, and serious deviations will lead to excess friction on the one hand or higher oil consumption and possibly wear on the other. The selection of viscosity is, however, so systematized as a result of experience and theory that there is little room to go seriously astray.

While the effect of heat on the physical characteristics (viscosity) is well known and adequately taken into account, the effect on the chemical nature of the oil is generally less understood. Lubricating oils absorb oxygen from the air with the formation of asphaltic sludges and the hotter they are the faster they sludge. The rate of sludging just about doubles for each 20 deg. F. increase in piston temperature. The important temperatures are those on the pistons, rings and cylinder walls, not those in the crankcase, which will be much lower depending on the rapidity of heat removal.

So much for oxygen absorption and sludging which occurs at crankcase and to a greater extent at piston and ring temperatures. Recent years have witnessed a marked improvement in the resistance of lubricating oils to this sort of deterioration. Improved refining methods have increased the sludge stability of the oil until now oils can be used much longer than formerly without the excessive sludge which would have resulted a decade ago. "Anti-sludge" oils are now available for internal combustion engine service, while one company markets an oil for steam turbine circulating systems which is guaranteed for the life of the turbine.

Heat also may cause a degradation of the oil with the formation of carbonaceous deposits, or in the language of the layman "coke" and "soot." These products are not formed at crankcase temperatures, but only at the much higher temperatures found around the rings, in the combustion space itself, or possibly on the under side of the piston. The excessive ring sticking sometimes found in Diesel engines generally is due largely to these "coke" deposits. The rapid accumulation of jet black deposits in the crankcase generally is found to be mostly "soot" scraped down from the high temperature zone or blown by leaky rings. Deposits which clog the ports of two cycle Diesel engines are most frequently from this source.

Of course poor combustion due to poor fuel or poor mechanical condition may contribute to all these deposits, but in well run engines operating on suitable fuels, deposits are largely a lubrication problem. Just as in the case of oxidation to asphaltic sludge, the oil technologist is able by proper selection of the crude and proper refining methods to reduce this tendency to form carbonaceous coke or sooty deposits. Since all oils are combustible hydrocarbons, the job may be attacked either by making an oil which will *not* appreciably degrade to carbonaceous residues at the prevailing temperatures or one which will "burn clean", leaving no appreciable residue. The oil to be avoided, if at all possible, is the oil which partially decomposes leaving a considerable residue which makes wonderful piston ring and exhaust port cement. The oil to be selected depends on the temperature conditions. At high piston and ring temperatures even the most resistant oils will be affected and unfortunately the most resistant oils

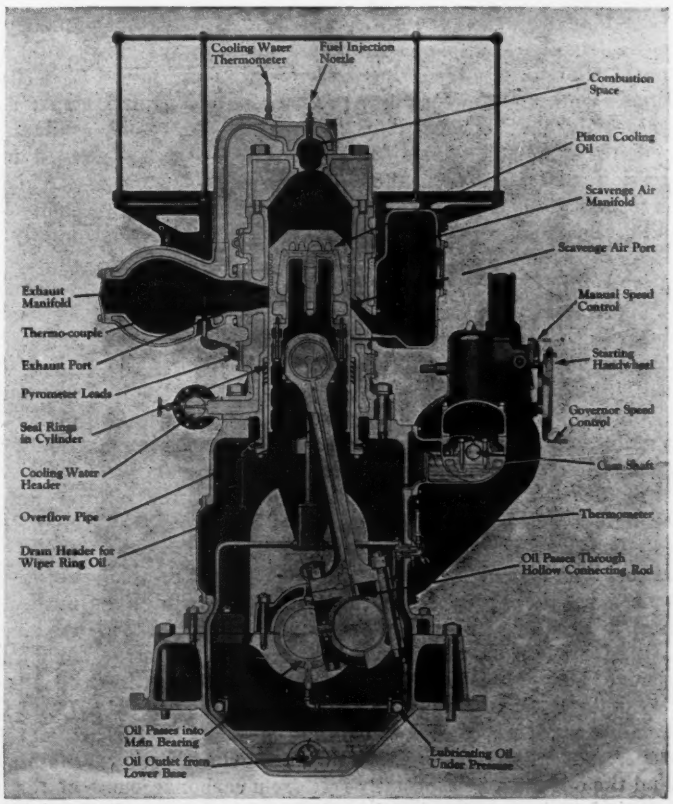


Fig. 1. Cross section of a Diesel engine showing facilities for lubrication and cooling

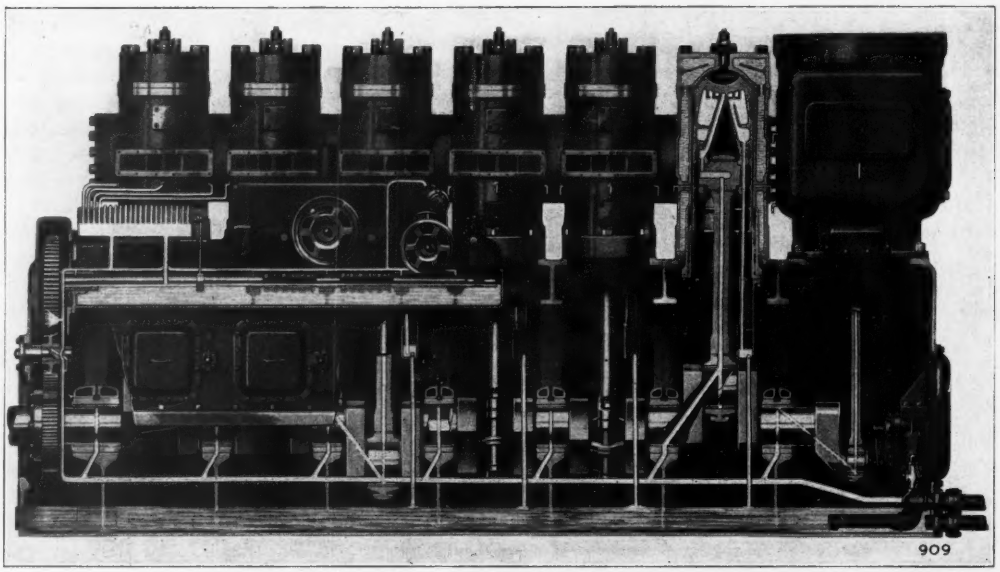


Fig. 2. Longitudinal section of a Diesel showing how oil is circulated under pressure through holes bored in the crank and connecting rods

seem to form the most carbonaceous deposits under such conditions. Therefore it frequently is necessary to resort to the other type of oil which is less stable but "burns clean" with a minimum of carbon deposits.

It is giving away no trade secrets to report that the lubrication engineer here faces his most difficult Diesel lubrication problem. Unfortunately, oils do not at present exist which will both adequately resist formation of coke residues under the temperature stresses encountered in many Diesel engines under heavy duty service and also are highly resistant to asphaltic sludging. Therefore, for best results the lubrication engineer frequently resorts to oils which are less stable but leave little or no carbonaceous residue. This may lead him into another pitfall since oils which show minimum carbonaceous deposits are prone to form asphaltic sludges from oxidation. Thus, it may turn out that while the exhaust ports may remain clean and the compression rings free for satisfactory periods of time, there may be serious trouble from crankcase sludges and oil control ring fouling.

As with many engineering problems, the best results usually are obtained by compromising the mutually conflicting requirements. Here the lubrication engineer with a wide selection of oils at his disposal is able to avoid many difficulties. A usual basis of selection may be as follows:

Class I conditions obviously require oils resistant to oxidation sludging only, since the high temperatures required for carbonaceous decomposition are never reached. Class II involves one pass only of the oil through the carbonizing temperature zone around the pistons and rings. Maximum resistance to coking or carbonization is required, but since the oil is not re-used it need not be highly resistant to asphaltic sludging since this requires prolonged exposure to heat and air.

Oils for Class III must in general meet the requirements of Class II oils. Used oil is supplied to the cylinders but the low crankcase temperatures so retard asphaltic sludge formation that high stability in this property usually is not highly important. On the other hand the oils must be especially free from carbonaceous deposit forming tendencies since exhaust ports as well as rings are favorable locations for their formation.

Class IV brings us to the most difficult as well as the most varied requirements from a lubrication standpoint. The continuous flow of heat to the crankcase oil and the repeated exposures of the oil to the higher piston and ring temperatures indicates use of an oil resistant to asphaltic sludging. Use of this same oil on the pistons and rings where carbonizing temperatures also are encountered, indicates an oil resistant to carbonizing. Matters are made worse if badly sludged oil is supplied to the cylinders, since such an oil is much more prone to leave ring binding deposits. Highest quality in both properties is impossible.

In practice, the selection depends on the relative severity of the sludging and carbonizing conditions. This usually depends on design but sometimes individual operating conditions influences the choice of oil to a marked degree. Where crankcase temperatures are high but carbonizing temperatures on the rings and pistons are not severe, it may be possible to use oils highly resistant to asphaltic sludging and also sufficiently resistant to carbonization at ring temperatures, with excellent all-around results.

Under more severe carbonizing conditions such a selection might lead to rapid ring sticking and voluminous "sooty" deposits in the crankcase. In such cases oils must be used which resist carbonization under piston and ring conditions, thus minimizing deposits, and if necessary avoid asphaltic oxidation sludges by more frequent draining of the crankcase oil.

Reference has been made to the "art" of lubrication. Lubrication is indeed an art and like medicine has not yet been reduced to an exact science. This is said not to belittle the work of the lubrication engineer, but rather to give him especial credit for such empirical advances as have been made. There is no adequate information as to temperatures prevailing in the various oil films where oxidation and carbonization take place. There is no laboratory apparatus that can be relied on to rate oils as they will perform in service. Reliance must still be placed on the judgment and experience of the engineer to meet the special problems, some of which have been touched upon above.

Diesel Engine Air Filters

Removal of dust reduces engine wear and lowers operating and maintenance expense. The filter design and layout should both receive attention if best results are to be obtained at minimum cost. The author has been closely identified with the industry for a decade and a half and has actively participated in much of the pioneer work in this field

By WM. K. GREGORY,

American Air Filter Co., Inc.,
Louisville, Ky.

DUST ELIMINATION from fuel air is now treated as an engineering problem of prime importance by every manufacturer of internal combustion engines. Every automobile, every truck, and every tractor leaves the factory with some kind of an air cleaner furnished as standard equipment and practically all manufacturers of stationary Diesel engines now insist that air filter protection be provided. In these past few years, air filtration has grown from an idea to an industry of considerable proportions. The first air cleaners appeared on passenger cars about 1924. These were tin cans with veins to give the air a rotating motion, and were supposed to throw the dust out by centrifugal action. These cleaners were not particularly efficient and while they undoubtedly did some good, their principal value was that they served as a starting point from which the present rather efficient oil coated cleaners have evolved.

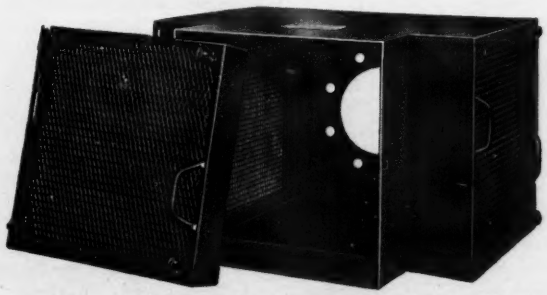


Fig. 1. The washable viscous filter is popular for stationary Diesels of all sizes. It is made up of standard size units for convenient mounting in frames

Many different types of air filters are manufactured to meet the specific air cleaning problems presented by various industries. All air filters fall into one of two general classifications: 1, The viscous impingement type; 2, the dry type. Under each of these general classifications are a number of subdivisions, the most important of which are as follows:

Air Filter Types

Under the viscous impingement classifications we have: a, the washable unit type filter illustrated in Fig. 1; b, the automatic and semi-automatic self-cleaning type, Fig. 2; the oil bath type, Fig. 3; and d, the renewable type used principally in warm air furnaces and small air conditioning plants.

Under the dry type we have: a, the felt type which is made with removable felt gloves, Fig. 4, and with other types of felt construction; b, the cellulose type in which the filtering material is inexpensive and is replaced when dirty, Fig. 5; and c, the renewable type, employing cellulose or cotton linters, which is completely replaced when dirty. The use of this type is confined to ventilation service.

Fig. 2. Because of the higher first cost, automatic or semi-automatic viscous impingement filters are used mostly on larger installations requiring an air flow of 5000 c.f.m. or above

Fig. 3. Oil bath filters are used mostly on the smaller 4 cycle engines of 100 h.p. or less. They give large capacities in small space, but the air resistance is higher than the type in Fig. 1

Manufacturers of Diesel engines were among the first to realize the importance of thoroughly cleaning air for combustion, and as soon as a practical air filter was placed on the market, they recognized its value and did not hesitate to recommend its use. All these manufacturers had experienced trouble with rapid wear of cylinders, pistons, piston rings and bearings, directly traceable to dust and it was unnecessary to conduct long tests on actual installations to convince them that an air filter was a good investment for their customers. The main thing an air filter manufacturer had to prove was that his filter would remove a high

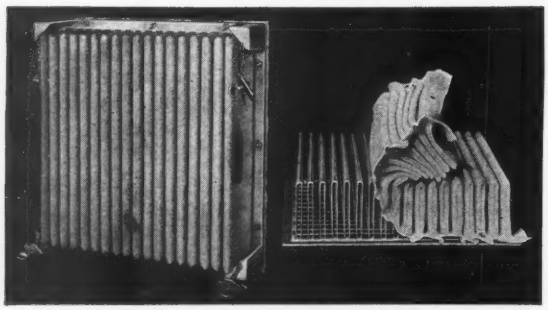


Fig. 4. In locations where the type of dust present does not wash off well the dry felt type filter is used. The view on the right shows how the felt "glove" is removed

percentage of dust, that it was not too difficult or expensive to maintain, and that it could be expected to last a reasonable length of time before requiring renewal. Having once been satisfied on these points, many Diesel manufacturers insisted that customers purchase air filters and practically all of them suggested their use.

Effect On Engine Costs

In actual practice it has been definitely proved, in numerous instances, that the use of air filters effects material savings in maintenance cost by reducing wear on cylinders, pistons, piston rings and bearings, and eliminates much valve trouble which would otherwise result. Actual statistics which give a fair indication of the value of air filter protection for stationary Diesel plants are almost impossible to obtain, as all the surveys made so far are incomplete and tell only part of the story. At the Mexia Texas plant of the Texas Utilities Co., air filters were installed on a 1250 hp. Nordberg Diesel engine which had been operated a number of years without air filter protection. A survey conducted by a disinterested engineer established the fact that valves were cleaned every 1500 hr. before filters were installed, and every 3000 hr. thereafter. This survey also indicated that the intervals between liner replacements had been increased in approximately the same proportion. Other surveys indicate a reduction in lubricating oil consumption ranging from 25 to 60 per cent, and show a return on the air filter investment ranging from 62.8 to 69.9 per cent after deducing interest on investment, depreciation and maintenance expense.

So much for air filters in general. The remaining portion of this article will deal with the types employed on Diesel engines, with the advantages and limitations of each.

Washable Viscous Impingement Type. The viscous impingement washable unit type filter, Fig. 1, was one of the first filters applied to Diesel engines. Important improvements have been made in filter media and other details which affect durability, but aside from this the present unit filter is essentially the same as the original filter of this type introduced in 1922. As a general rule, the required number of filter cells is mounted in a welded steel housing by the air filter manufacturer, who also provides suitable opening and bolt holes for connection to the air intake pipe. This makes installation simply a matter of bolting the housing in place. The advantages of viscous impingement washable unit type filters are: A high cleaning efficiency; low initial resistance; a large amount of dust can be accumulated before resistance to air flow is materially increased; they are durable and can be expected to serve efficiently for 10 yr. or more if given a reasonable amount of attention; first cost is reasonable; and maintenance is inexpensive. The only objectionable feature of this type filter is that it requires washing and recharging with oil at intervals which normally vary from 4 to 6 wk., and in plants where maintenance is not well supervised they are occasionally neglected, with the result that their efficiency is impaired.

Felt Dry Type. The felt dry type filter, Fig. 4, is particularly well adapted to: jobs where some special type of dust which cannot be readily removed from a viscous type filter by the ordinary washing process is encountered and flour dust in particular comes under this heading; in locations where no oil or coal smoke is present and the relative humidity is low so much of the dust will shake off, due to engine vibration, or, can be removed by a vacuum cleaner. If the felt is in the form of a removable glove, or a flat piece of cloth, it can be dry cleaned several times for the removal of any oily deposit which might have been accumulated. Cleaning efficiency is higher than any other type filter when felt is new.

No maintenance is required for several months as a rule and under certain atmospheric conditions they may operate satisfactorily for a year or more without maintenance. First cost is about the same as a viscous impingement washable unit type filter of the same capacity. The principal disadvantage of the felt type is that from the day it goes into service, the cleaning efficiency starts decreasing due to the abrasive action of the dust and the resistance to air flow starts increasing due to plugging of the minute air passages when a dust particle of just the right size comes along. Ultimately it is necessary to renew the felt element, and if a high efficiency and reasonable air resistance are to be maintained, a renewal is usually required every year or two. This results in a maintenance cost considerably in excess of the viscous impingement washable unit type, which is partially compensated for by the fact that less frequent maintenance is usually required.

Cellulose Dry Type. The cellulose dry type filter, Fig. 5, is an excellent air cleaner for certain type

Fig. 5. Although the dry cellulose filter has a wide industrial application it is not as widely used in the Diesel field as the other types

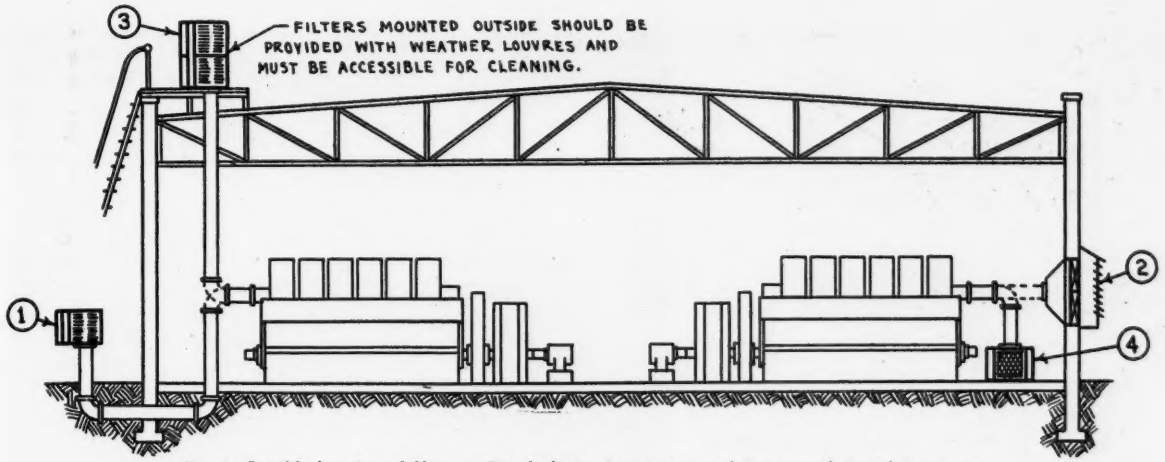


Fig. 6. Possible location of filters in Diesel plants. Locations 1 and 2 are good, 3 and 4 are not

of ventilation and industrial service, and while it has been successfully employed on Diesel engines, it is not as well adapted to this field as some of the other types.

Automatic Viscous Impingement Type. Filters of the type illustrated in Fig. 2 are available in either automatic or semi-automatic units. They consist of a number of individual filter cells which are periodically moved from an oil tank in the base, first, to a position out of the air stream where they drain for 24 hr., and second, into the filter curtain. Under normal dust conditions one cell per day is moved either by a hand crank or by an automatic electric drive. During dust storms the cells may be rotated more frequently.

Advantages of the automatic or semi-automatic filter are: the type of maintenance required is very simple, very little time is required even on the semi-automatic type and consequently such a filter is less apt to be neglected by the maintenance crew. The cleaning efficiency is high, and the dust-holding capacity is such that with daily rotation of cells the resistance never builds up to the point where air flow is reduced a noticeable amount. The only disadvantage to this type filter is that its first cost is considerably higher than the washable unit viscous impingement type filter, especially for air capacities less than 5,000 c.f.m.

Oil Bath Filters. The principal application of oil bath filters, Fig. 3, is to small high speed multi-cylinder four-cycle engines (gasoline, gas and Diesel) which develop less than 100 hp. Their main advantage is: Larger dust-holding capacity than washable filters of similar size; and ease of maintenance. The disadvantage of this type is their relatively high resistance to air flow as compared to washable viscous filters. Oil bath cleaners usually have a resistance of from 3 to 10 in. of water at rated capacity as compared to 0.25 to 0.50 in. for washable viscous filters. For this reason may reduce the power delivery of 2-cycle crank case scavenged engines.

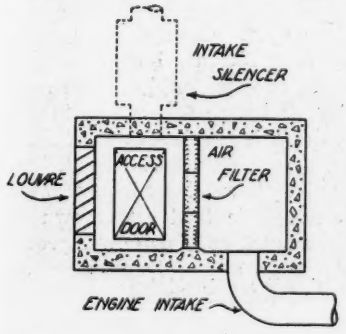


Fig. 7. Typical construction of an outdoor filter house suitable for an air flow of 5000 c.f.m. or more and for different types of filters

Designing an Air Filter Installation

In designing an air filter installation for a Diesel plant, the most important points are:

1. Locate filters at a point where they are easily reached for servicing. This is most important.

2. Make sure that all connections between filter and air intake pipe are absolutely air-tight, so no unfiltered air can leak through.

3. See that air filters are protected from rain, snow, etc., by providing suitable weather louvres, or other protection.

As a matter of general practice, air for large Diesel engines is usually taken from outside the engine room, as it is practically impossible to adequately heat an engine room in winter if inside air is used for combustion.

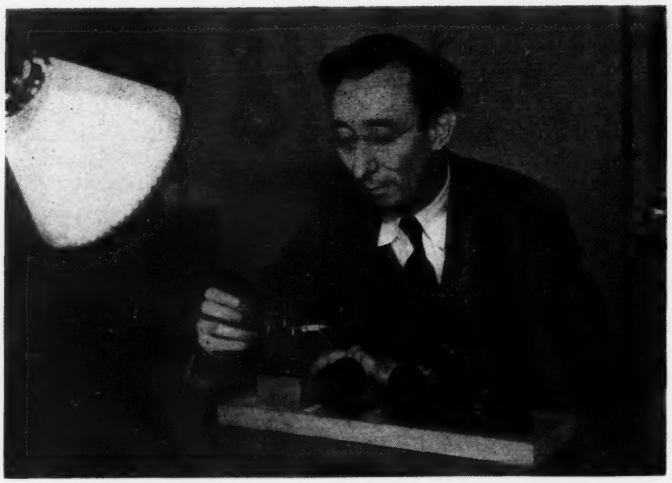
Several methods of installing air filters are indicated in Fig. 6. An installation as indicated at 1 is suggested for engines which require less than 5000 c.f.m., although installation shown at 2 is entirely satisfactory. Installation marked 4 is rarely used and installation marked 3 is undesirable as filters are apt to be neglected.

Figure 7 shows another type of outside installation for engines requiring 5000 c.f.m. or more, in which a filter house is built outside the engine room. The filter employed in an arrangement of this type can be an automatic, semi-automatic or unit viscous type. Such a filter house should be made preferably of concrete, although brick or steel can be employed. Note that an access door is provided on the dirty air side of the filter for servicing. Air can either be taken through weather louvres on the front of house or through a pipe which connects to an intake silencer on the roof of filter house.

Proper air filtration is a real engineering problem. Of all the filters on the market no one of them will satisfactorily handle every air cleaning problem and each type has its own peculiar advantages which make it particularly well suited to certain applications.

Part XVIII

By A. W. Kramer



Dr. C. W. Hewlett of the General Electric Research Laboratory with sun-driven motor

Electron Tubes— Principles and Applications

THE MECHANISM of the photoelectric cell is not nearly as well understood as is that of the photo-emissive tube discussed in Chapters XV and XVI of this series. It would seem logical that the fundamental principle involved in these cells is photo-emission and attempts have been made to explain their action on this basis but these attempts have not generally been successful. In a number of instances the results seem to contradict this theory.

Despite the uncertainty regarding its action, the development of these photoelectric devices has gone forward rapidly and as pointed out in the preceding article a number of different types are in successful commercial use. At the present time their greatest use is as light meters and as exposure meters in photography but they are also in use in many industrial applications such as the smoke indicator referred to in the preceding article.

In view of this growing use, it will be to our advantage to study them in somewhat greater detail. They constitute a special class of electronic devices which may well prove of great consequence in future years. For these little cells are man's most successful attempt, thus far, in converting power from the sun into useful energy directly. True, their efficiency as a conversion device is very low, only some 0.6 per cent, but it may be possible that new discoveries will enable us to raise that. Even with these cells, minute as they are, it has been possible to drive a small electric motor. This was accomplished in the General Electric Research Laboratory. The motor was a tiny affair rated at only four ten millionths of a horsepower but in direct sunlight four of these small photovoltaic cells operated it at about 400 r.p.m. Naturally, it must not be inferred that this method will be improved to such an extent as to make the commercial production of electric power direct from the sun possible, but it is interesting from a scientific standpoint and some day somebody may make a more efficient cell. On the basis of the cells used by the General Electric Co. in this experiment, some 20 sq. ft. of active surface would be necessary to produce one watt. If the efficiency of these cells could be brought to say even 10 per cent, a square mile of such surface would provide a power output of approximately a half million kilowatts from the sun.

Aside from this aspect of their use, these devices will find increasing usefulness in many commercial and industrial applications. Their power yield per unit of light is very high as compared to the vacuum phototube and where frequency is not a limiting consideration they have many advantages over the vacuum phototube.

As already stated, the operation of these cells is based upon a discovery that Becquerel made over a century ago; i.e., that when two similar electrodes were immersed in an electrolyte and one of them illuminated more than the other, a voltage is developed and if these electrodes are connected by a wire, a current will flow in this wire. This very principle was later incorporated in the cuprous-oxide electrolytic lead cell shown in Fig. 1. This cell as will be noted consists of a cuprous-oxide-coated copper electrode and a lead electrode, immersed in a lead nitrate electrolyte. Light shines through a glass window on the cuprous-oxide surface.

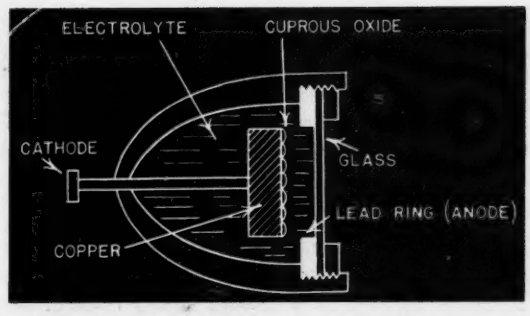


Fig. 1. Diagram of a cuprous-oxide, electrolytic, light sensitive cell

With a low resistance galvanometer, the current from this cell is a strictly linear function of the illumination and it may be used to measure lumination intensity but at the present time the dry type of cell is used almost exclusively for this purpose.

The Dry Type Photovoltaic Cell

In considering the action of the dry type of cell, we will begin with the copper-oxide cell. If clean copper is subjected to a proper oxidizing treatment, a reddish crystalline layer of cuprous-oxide forms on its surface. This is well known and there is nothing mysterious about the process, but it has been found that the dividing surface between the mother copper and the oxide exhibits some very remarkable properties. It is a highly efficient rectifier of alternating currents for low voltages. As shown by the graph in Fig. 2 for voltages up to about three (maximum), a few square inches of surface, amperes pass in the permeable direction while only milliamperes pass in the opposite direction. In using this surface as a rectifier, the mother copper forms one terminal and some soft metal such as lead or tinfoil pressed against the surface of the oxide forms the other. In commercial forms, the outer surface of the oxide is copper plated and this forms the other terminal. It might be thought that by using two copper surfaces as the terminals in this manner that the rectifying action would disappear, but this is not so,

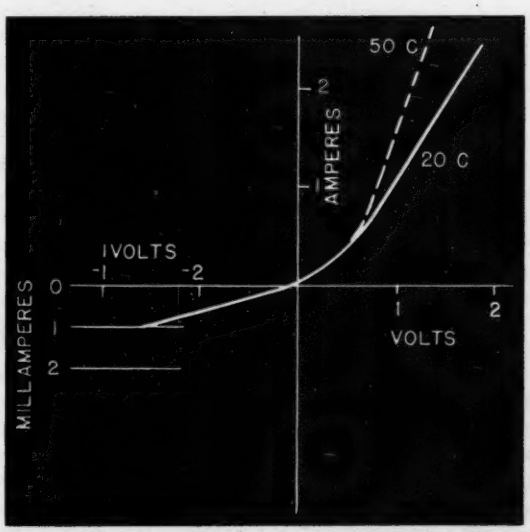


Fig. 2. Curve showing the rectifying action of the cell shown in Fig. 1

the rectifying action seems to depend upon the peculiar bond between the cuprous-oxide and the metal upon which it is formed. This rectifying property is effective only up to about 3 volts. If too much inverse voltage is applied the cell overheats and the action spoiled by the cracking of the oxide away from the copper.

The rectifying action of the copper oxide cell was known before its photoelectric properties were discovered. Here again it will be noted, as was the case with electron tubes, rectification is a fundamental property of the photovoltaic cell; indeed rectification seems to be a fundamental property of most electronic devices. In 1926 Groudahl showed that the copper-copper oxide surface could be used as a source of photovoltage. He pressed a spiral of copper wire against the surface of the oxide with space between the turns so that light could shine through onto the oxide and found that when the oxide was illuminated a current flowed through a galvanometer connected to the mother copper and the spiral as in Fig. 3.

Direction of Electron Flow in Cells

An interesting thing about these oxide cells is that when they are used as rectifiers, the direction of electron flow is from the copper to the cuprous-oxide; that

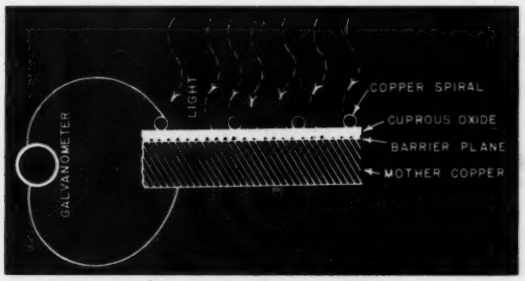


Fig. 3. Greatly enlarged section of a cuprous-oxide-copper type of cell

is, with an impressed voltage, electrons can pass the boundary from the copper to the cuprous-oxide easily but are blocked when they try to pass the barrier in the reverse direction. When the cell is used as a source of photovoltage, that is when light produces the voltage in the circuit, electrons flow across the boundary from the oxide to the copper! This anomalous action has not been explained and the operation of these cells is not fully understood despite their increasing commercial use.

Commercial Types of Cells

As pointed out in the preceding article, there are a number of different forms of these cells on the market. The Copper-Cuprous Oxide cell described above is sold by the Westinghouse Electric and Manufacturing Co. under the name of Photox. This is essentially the same as the unit described above except that the oxide is covered with a thin layer of gold which is transparent to light, the gold serving as one of the electrodes.

The General Electric light sensitive cell consists of a layer of selenium deposited on the surface of a steel plate, about 1.1 sq. in. in area. Over this layer of selenium, two transparent layers of conducting metal are deposited, making the negative terminal of the cell.

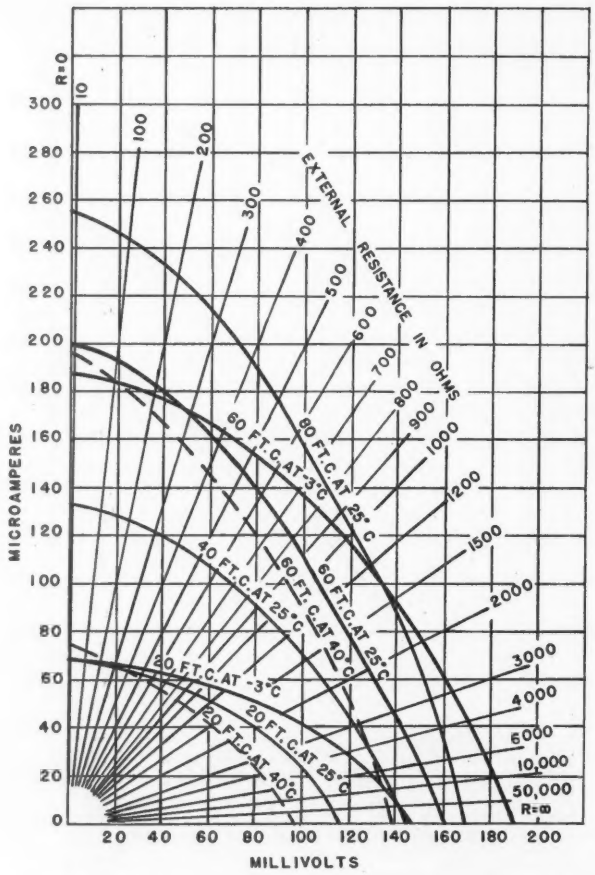


Fig. 4. Master chart showing the characteristics of the General Electric light sensitive cell

In Fig. 4 is shown a master curve of the characteristics of the General Electric cell. This chart shows the voltage current data plotted at constant values of temperature for various values of illumination. Superimposed on these curves are the voltage current relations for a full range of resistance values which are shown as straight lines drawn out from the origin. At any illumination, the external potential can be determined for all values of current or resistance, and hence, the power available under these conditions. The variations of the voltage-current characteristics are given at –3 deg. C and +40 deg. C for 20 and 60 foot-candles. From these curves, any desired information on the cell may be derived within the given range of illumination.

An example may serve to clarify the use of these curves. Suppose the current output at 700 ohms is desired from an illumination of 80 foot-candles and at a temperature of 25 deg. C. The 700 ohm resistance line crosses the 80 foot-candle voltage-current curve at a point which has a current co-ordinate of 150 microamperes, and a voltage co-ordinate of 105 millivolts. Therefore, the cell will deliver 150 microamperes on an external resistance or equivalent load of 700 ohms. This means that the external power is $150 \times 0.105 = 15.8$ microwatts.[1]

The Weston Photronic Cell consists essentially of a thin metal disc on which there is a film of light sensitive material, such as iron selenide. The metal disc forms the positive terminal and a metal collector ring in contact with the light sensitive surface forms the negative terminal. The cell is contained in a case having a window of glass or quartz depending upon whether the cell is to be used only in the visible or infra-red regions of the spectrum, or in the ultra-violet.

The current output of the Weston cell as it is of other makes of photovoltaic cells in linear for low resistances. This holds for illumination intensities of from zero to as high as 10,000 to 15,000 foot-candles, hence, they serve very effectively as light meters. The current output of the average cell is about 1.4 microamperes per ft. candle of illumination uniformly distributed over the sensitive surface and with a low external resistance. The output of the average cell is 120 microamperes per lumen, but of course this varies with the amount of external resistance in the circuit. Curves showing the effect of external resistance for the Weston cell are shown in Fig. 5.

The Electrocell self generating dry disc photoelectric elements, also consist of a semi-conductive layer deposited on the surface of an iron disc and overlayed by a transparent conducting film. These are available in various sizes in either the round or rectangular form. They generate up to 0.6 volts and deliver 480 microamperes per lumen with negligible resistance in the circuit.

Dynamic Response

The Electrocell, although similar in construction to other photovoltaic cells, has quite different characteristics, particularly with respect to frequency response. Tests indicate that the Weston Photronic cell is not suitable for use at audio frequencies such as are used for example in talking pictures. The frequency response of the cell diminishes with increasing frequency due largely to the shunting effect of the internal capacitance of the cell, which is of the order of 0.5 microfarad, and is approximately inversely proportional to it. If the response at 60 cycles is assumed 100 per cent, that at 120 cycles will be about 58 per cent, that at 240 cycles will be about 30 per cent, at 1000 cycles about 6.4 per cent and so on as the frequency increases. This reduction in current output of the Photronic cell with high incident light frequencies is quite characteristic of photovoltaic cells in general but the Electrocell differs in this respect. These units have a high "dynamic" response and their electrical performance drops to only 40 per cent at frequencies as high as 6000 cycles per second. This makes these cells applicable for sound production and recording. The slight decrease in output at high frequencies causes some attenuation of the higher notes, but since the effect is caused by the capacitance of the elements, it can be offset by using a suitable inductance reactance in the circuit.

This difference in the dynamic response of these different cells is due to a difference in the proportion of photo-conductive effect. The true photoelectric effect as exhibited at the active surface of the vacuum phototube has no appreciable time lag; the electrons are emitted simultaneously with the incidence of light. The dynamic response of such a cell is independent of frequency of fluctuation of the impressed light beam.

[1]For more complete data on these cells, see Bulletin GEA-2467 issued by the General Electric Co.

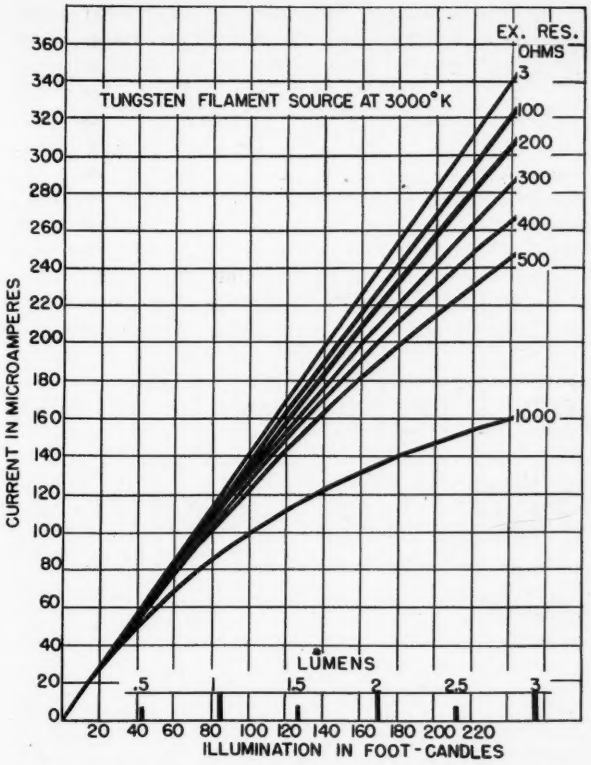


Fig. 5. Chart showing the effect of external resistance upon the current output of the Weston Photronic cell

The light may fluctuate in intensity millions of times per second and the variation in phototube current will be exactly the same as when the frequency of light variation is a few cycles per second. The dynamic response of such vacuum phototubes has no relation whatever to frequency.

The fact that the response of photovoltaic cells does vary with frequency seems to indicate that the current flowing in these cells is of secondary origin. The process of producing this current takes a comparatively long time, quite a large fraction of a second. It is this fact that makes it evident that the action in these cells is not photoelectric in the true sense. Quite probably there is a small true photoelectric current which appears simultaneously with the incident light but this current is so small compared to that which results from secondary action that its effect on the total response of the cell is not discernible. Even in those cells with a high dynamic response, the time lag is still such as to imply that the current is largely of secondary origin.

We have gone into some detail in discussing these cells because they are extremely compact and useful devices. The fact that their current output is sufficiently high to operate galvanometers, measuring instruments and relays without additional amplifiers, makes them very desirable for certain applications. For all relay work the cell response is so much more rapid than it is possible to make such relays that it may be considered instantaneous. By actual test the speed of response of the Weston Photronic cell was sufficiently rapid to record the passage of a rifle bullet through a beam of light incident upon the cell.

New Light on the Electric Arc

THE electric arc is associated with the very beginnings of the electrical manufacturing industry. The early electric generators were rated by the number of carbon arc lamps they could supply, and the generator, the lamps, and the lamp circuit were the prototypes of our modern distribution system.

Today the arc, in the form of the mercury and sodium lamps, is again serving prominently in the field of illumination; in electric welding the arc has found a new and expanding sphere of usefulness. In many forms of electric apparatus, such as switches, contactors, commutators, or circuit breakers, arc phenomena may appear as a nuisance to be suppressed.

In view of the obvious practical importance of the arc, it is remarkable how little it has been studied and how little has been known about its real nature. Research workers in Europe and America, chiefly in industrial laboratories, have been making up for lost time, however, in the study of the arc and during the past few years have established knowledge of the phenomenon on a really scientific foundation.

Some of the new facts which have been discovered about the arc are as surprising as the methods which are being used to obtain them. By photographing the sound wave in the core of a welding arc, it is found that the temperature of this hot gas ranges around 10,300 deg. F, or somewhat higher than that at the surface of the sun. At this temperature, air molecules are broken up into atoms; as atoms they are extremely efficient in heating by the recombination process formerly thought to be associated only with the atomic hydrogen welding method.

By measuring the arc characteristic in various gases over a range of pressures between a fraction of a pound and 19,000 lb. per square inch, it is found that arcs adjust their characteristics to suit the gas, considered as a cooling medium. The arc characteristics in various gases are all the same if the pressures are so chosen that the gases have the same effectiveness in transferring heat.

Thus the concept of the arc as a thermal mechanism is becoming more and more firmly established as the basis for understanding the behavior of this electric discharge.—Dr. C. G. Suits, G-E Research Laboratory.

WHEN INSTALLING new electric furnaces which carry current of some 50,000 amp., International Graphite and Electrode Corp. of Niagara Falls, N. Y., was faced with the problem of durable construction for severe conditions, also the avoidance of high induction and hysteresis losses. At take off points from the main buses to furnaces and at connections from buses to electrodes, clamps of non-ferrous metal have formerly been used, but in the new units Ni-Resist metal, which is nonmagnetic, was adopted with considerable saving in cost. Bus bars are 8 by ⅜ in., so that the clamps are accordingly large.

In the May issue of "Electronics" W. S. Wilder, technical assistant to the chief electrical engineer of the Milwaukee Electric Railway and Light Company, describes the existing installation of phototube equipment to a difficult situation. Having solved this problem, a still more complex one presents itself, that of projecting a ray of light across 40 feet of boiler breeching, filled with rapidly moving gases, onto the small area of a phototube. Because of its specific interest the power plant engineers, Mr. Wilder's article is reprinted here.

An Electronic Problem in Flue Gas Control

By W. S. WILDER

THE PHOTOTUBE APPLICATION that we have under consideration is the logical sequence to our recent installation of which we believe to be the successful solution of the most difficult smoke indicating phototube application installed to date. The installation now in service successfully indicates flue gas conditions in the discharge breeching of a 690,000 lb. per hr. boiler, burning powdered coal applied to the furnace through twenty burners. Due to the boiler discharge breeching leaving the boiler casing in two sections, it was necessary to resort to a rather unique mounting arrangement for the phototube equipment.

Due to the presence of smoke washers between the induced draft fans and the stack, the only suitable place where the phototube equipment could be mounted was on the induced draft fan casings. The two induced draft fans are mounted in their respective casings, parallel to each other in such a manner that by connecting a piece of 4 in. pipe 14½ ft. long between the casings, and mounting the phototube and light source on the two fan casings opposite this connecting pipe, the light beam was made to traverse the flue gas discharge area of the two fans, thus securing an indication of flue gas conditions across the discharge of the boiler. The wrought iron pipe, after some experimentation, was kept clear of smoke and ash by placing a glass partition across it at middle distance from either end, and installing air vents adjacent to this partition so that the partial vacuum in the induced draft fan chamber would draw fresh air across the face of the glass partition and through the connecting 4 in. pipe. By thus keeping the interior of the glass clear, the light beam from the phototube light source in its passage through the induced draft fan chambers and interconnecting pipe is intercepted only by flue gases in the induced draft fans.

Due to the use of powdered coal as a furnace fuel, the furnace flue gases are normally far from transparent, even under ideal combustion conditions. The problem in the phototube application was to detect changes in flue gas density, due to the presence of unconsumed combustibles (soot). The application, which has been made successfully, detects changes in flue gas density within 5 per cent. Experience has indicated that over a wide range of firing conditions, the density of the boiler flue gases under proper firing conditions varies but slightly, so that an alarm relay functioning in conjunction with the phototube detector can be set to sound a warning when combustion is not satisfactory. The application that has been made successfully detects changes in flue gas density, due to variation in the adjustment of one out of the twenty pulverized fuel firing burners. It is thus possible not only to detect the presence of smoke being emitted from the stacks, but to check upon combustion conditions in the furnace and the adjustment of individual burners on a large boiler. Even a slight improvement in efficiency by reduction in combustibles in the discharge gases will, in a year's time, result in savings far in excess of the cost of the phototube equipment.

The equipment which has been successfully installed is a General Electric type CR-7505-Y1 phototube and their type CR-7500-Y5 light source. A 50 c.p. automobile headlight-type lamp is used in the light source. The phototube is of the gas-filled type. In addition to the light source and phototube, a strip-chart type recording milliammeter provides a continuous record of flue gas conditions.

The New Problem

The problem which now confronts us requires the projection of a beam across 40 ft. of boiler breeching, or the application of two phototubes in two discharge breechings in parallel. Two phototubes, since they must indicate conditions in the double discharge from one boiler, should be connected so as to operate one milliammeter. Obviously, the first approach to our problem suggests the procurement of a powerful light

source which will penetrate 40 ft. of flue gases with a concentrated beam so as to give a high intensity on a small surface of a phototube. A careful survey of the market indicates there is no commercially available light source with a concentrated beam which will project a high intensity light on the small area of a photocell 40 ft. away. Special lights, such as used in motion picture projectors, are available with suitable lenses for the application we have in mind, but when it is considered that the light source must be on continuously 24 hr. a day., year in and year out, the high cost of these projection bulbs removes them from serious consideration. It is possible to build up a suitable reflector, using long-life, low-cost lights, but such a job would be special and run into more money than we care to invest in an experiment.

It has been suggested that a phototube device operating on a reflection principle might be more sensitive to color changes in boiler flue gases than a photocell operated by a penetrating beam. Naturally the presence of even a small amount of soot in the light gray fly ash in the boiler discharge gases changes the color of the gasses and their reflecting properties.

Millions Saved by New Filament

PERFECTION of a new high-efficiency tungsten filament, which will increase the light output of incandescent lamps 10 per cent without using any additional electrical current, was announced recently by J. E. Kewley, vice-president of General Electric's incandescent lamp department at Nela Park.

This development, declared by engineers to be the greatest forward step in tungsten filament lamp since the invention of the gas-filled lamp in 1913, will provide a "lighting bonus" or saving of $16,500,000 to the public this year, Mr. Kewley declared in his announcement made to utility engineers from all parts of the country gathered here for the annual Advanced Lighting Conference. By 1946, he said, the annual lighting bonus will amount to well over $60,000,000, with the total value of all such bonuses during the next five years exceeding $200,000,000. A "lighting bonus," he explained, represents the greater amount of light produced by improved lamps in a given year over that provided by the same quantity and types of lamps used in a previous year, at the same current cost.

Taking the 60-watt lamp of the 100-130-v. class as an example, Mr. Kewley pointed out the new filament would provide extra illumination which, at average rates, would cost 30 cents a year, or twice the purchase price of the lamp, and at no extra cost to the user.

The new high-efficiency filament climaxes 24 yr. of continuous research in the lamp development laboratories, Mr. Kewley declared, and follows a series of successive improvements in the chemical handling, fabrication, and manufacturing application of tungsten wire.

First drawn into a straight wire 19/10,000ths of an inch in diameter, so fine as to be almost invisible to the naked eye, the tungsten is then wound, 335 turns to the inch, around a thin molybdenum wire, or mandrel, leaving the coils, or turns, 1/1000th of an inch apart. These coils must be kept as close together as possible, to reduce heat loss, but must not touch each other, else they would short-circuit, causing the lamp to fail instantly.

Then the coiled wire is coiled once more on another mandrel, 70 turns per inch, with a spacing of 7/1000ths of an inch between the secondary coils. Before the first coiling, the tungsten wire in a filament is 20 in. long. The first coiling compresses it to a length of 3.4 in. The second coiling compresses it still further to a length of ⅝ in., with a coil-diameter of 310/10,000ths of an inch. Following the second coiling, the mandrels or center wires are dissolved by means of chemicals.

When installed in the lamp, the new filament is mounted as a cross-bar between two lead-in wires, with one support in the center of the filament, instead of being looped around three supports, as was the practice with the older type of coiled filament.

The new filament development solves one of the oldest and most stubborn problems involved in lamp manufacture. In a pure vacuum, a tungsten filament operating at a high temperature tends to evaporate quickly, and deposit its particles on the inner surface of the bulb, thus causing bulb-blackening and decreased light output. The use of certain gases within the bulb introduces pressure which reduces filament evaporation, with its attendant evil of blackening, and allows it to operate at a higher temperature for the same life.

Offsetting these advantages, the presence of gas inside the bulb gives rise to convection currents, or "breezes," which tend to fan the filament and lower its temperature, thus reducing its light output.

Dr. Irving Langmuir, of General Electric's research laboratories in Schenectady, in his invention of the gas-filled lamp, discovered that the greater the concentration of the filament, particularly in length, the lower the heat loss. Since the effective length of the new design filament is only about one-half that of the old, there is much less cooling by the gas which permits the lamp to give 10 per cent more light for the same amount of electric current. The gas employed in the new lamps is a mixture of nitrogen and argon.

Although the development will substantially increase manufacturing costs, resultant improvements in the quality of the lamps will, in accordance with company policy, be passed on to the public at no increase in prices, Mr. Kewley said.

Peat in 1936

PRODUCTION OF PEAT in the United States increased substantially in 1936, according to reports received by the Bureau of Mines from operators of commercial plants that were active during the year. The total production of peat and peat humus in 1936 amounted to 46,126 short tons, valued at $266,883, against 37,060 tons valued at $199,377 in 1935. In addition to the larger domestic output, imports of peat moss reached the record figure of 75,066 tons, making a total of 121,192 tons of peat available for domestic consumption in 1936 compared with 91,607 tons in the previous year—an increase of 32 per cent.

Milwaukee

A. I. E. E. Members inspecting steam turbine blade models on inspection trip through Allis Chalmers Co. plant.

NOT EVEN the thrill of free beer at Schlitz, nor the romantic spell of a moonlight cruise on Lake Michigan could dispel entirely the introspective attitude which the electrical engineers brought with them to the Summer Convention of the A.I.E.E. at Milwaukee last month. True, they partook of these delights with all the joy and enthusiasm that marks the intelligent person's capacity for relaxation and pleasure but whenever they returned to the meeting rooms or in their informal chats they reverted to the serious business of discussing their own shortcomings. In putting it this way don't let us mislead you into thinking that this meeting was a dull affair given over to academic matters of little practical importance for we imply no such thing. This meeting, in fact, was one of the most interesting we attended in years, notwithstanding even last winter's sessions on tensors[1] and the critical attitude that prevailed only served to accentuate the keen spirit of the organization and the profession it so ably represents. There seemed to be feeling of impatience with things as they are, in engineering education, in Institute publications and in the engineer's relation to social and political affairs, and in those sessions which were not given over to technical matters most of the discussion centered about these topics. Although the technical sessions were unusually substantial, throughout the entire week a spirit of intense interest in these other matters prevailed and the discussion was animated and forceful.

There was a feeling on the part of a small minority that engineers should participate to a greater extent in public affairs and who urged that the Institute as an organization should engage actively in political affairs and in other fields relating to social welfare. This view was roundly criticized by the majority of those who discussed the subject, however, and the idea was given a more or less general "thumbs down." Regardless of what one's personal opinion might be concerning present government policies and their relation to the electrical industry, the consensus of opinion was that the American Institute of Electrical Engineers was a scientific body and that regardless of what part members as individuals might play in politics and social work, the Institute as an organization should keep clear of these matters.

It is of course perfectly reasonable that such matters should be discussed at the Institute meetings since the engineer has a right to question his relation to the general social order and as an individual and as part of other organizations has a right and duty to engage actively in political and economic activities but unfortunately, those who advocated the entrance of the A.I.E.E. into politics were largely of one point of view. The action which they suggested—almost demanded—was action only in support of their own views. One could not help feel that their motives were dictated not so much to further the welfare of the existing order as to protect their own personal interests. It does not seem to have occurred to them that there might be others among the Institute membership whose views might differ from their own.

In this respect an orchid goes to L. W. W. Morrow who, as chairman of the General Session on Wednesday morning, did not permit the meeting to degenerate into a useless demonstration of political prejudices. His gentle but remarkably firm refusal to grant the request of one of the speakers to put certain questions of dubious merit to a vote was admirable.

Another orchid, a whole bunch of them in fact, should go to Professor Whitehead of Johns Hopkins for his splendid discussion of this subject as related to A.I.E.E. tradition and policy at this same meeting. In brief but vigorous fashion, Dr Whitehead outlined and pointed to the place of authority and dignity it occupied because of its adherance to purely technical and scientific matters. Now, said Dr. Whitehead, it has been suggested that the Institute engage in political affairs *without bias.* His implication as to the absurdity of such a course needed no elaboration. Where, he asked, would the A.I.E.E. get in an examination of Passamaquoddy or T. V. A. when there are wide differences of opinion on these matters even within the engineering boards of their own ranks?

Much of the discussion on these subjects took place at this General Session on Wednesday morning which was opened by an address by Ralph Flanders. Mr.

[1]Electrical Engineers Look at Tensors Then Sail For Bermuda. March 1937 issue, page 192.

Finds Electrical Engineers in an Introspective Mood

Over One Thousand Members and Guests Attend Summer Convention of the American Institute of Electrical Engineers at the Schroeder Hotel, Milwaukee, Wis., June 21-25.

Flanders is well known as an engineer-economist and his address, "The Engineer in a Changing World," was a splendid analysis of the social and economic problems which confront the engineer today. His intelligent, tolerant attitude implied a deep understanding of social conditions and he did not suggest that the engineers should take it upon themselves to revolutionize society, although their part in society was as important as that of any other group.

Dean Bush vs. Lewis-Braddock

Dr. Vannevar Bush, vice president and Dean of the School of Engineering at M. I. T., who addressed the convention on Tuesday evening was more specific in his recommendations as to the course the engineer should pursue in dealing with the government. The subject of his address was "The Engineer and His Relation to the Government." Dr. Bush suggested more specific action by all the engineering groups through an organization such as American Engineering Council. It was interesting to compare these two addresses by Dr. Flanders and Dr. Bush since Dr. Flanders spoke more as an economist or sociologist while Dean Bush's attitude was quite that of an engineer.

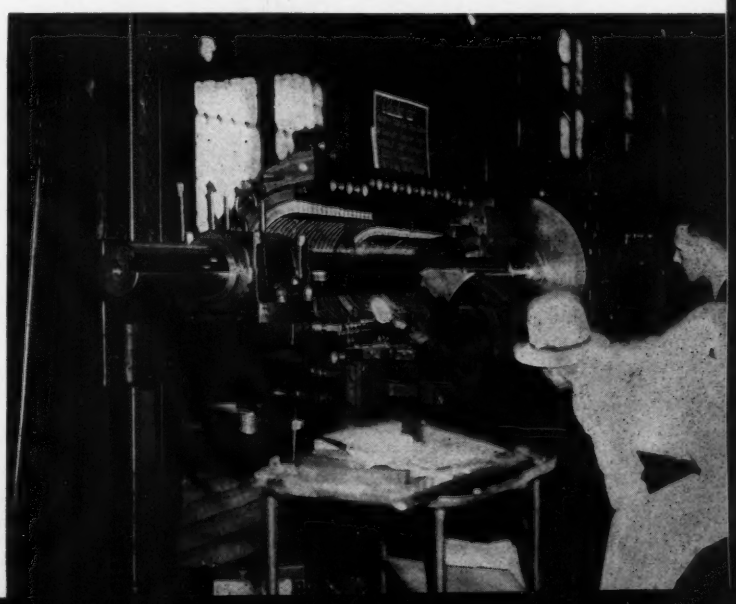
It was unfortunate that the effect of both of these addresses was marred by the poor facilities provided by the Schroeder Hotel and the gross carelessness in the operation of the public address system. The hotel in fact deserves a big demerit in this respect. The sudden interruption of Dean Bush's speech by the Louis-Braddock fight broadcast might have been excusable once but when it occurred a second time it was too tragic even to be comic.

This was the second large convention of electrical men we attended within a month where the shortcomings of the public address system were forcibly impressed upon those present. In view of the development of the art of sound reproduction today such performance, especially at a convention of electrical enineers, is inexcusable. There is no reason why automatic volume control should not be incorporated in public address systems, today, but aside from that, some judgment might at least be displayed in arranging loud speakers so as to prevent mutual interference.

Five Hundred Attend Allis-Chalmers Luncheon

An important part of this convention was the fine inspection trips and the entertainment provided by the Milwaukee local committees. The reputation that Milwaukee has for good food and hospitality was upheld to an admirable degree. One of the highlights of the week was the luncheon on Wednesday noon with the Allis-Chalmers Co. as host. Some 500 members and guests attended this luncheon which was given at the Allis-Chalmers plant, and followed by an inspection trip through the plant. General Otto H. Falk, Chairman of the Board of Allis-Chalmers and honorary chairman of the convention, delivered a short address at this luncheon and then invited the members to inspect the plant.

Other inspection trips included the Harnischfeger Corporation, Cutler-Hammer, Inc., A. O. Smith, the Schlitz Brewing Co., the Allen Bradley Co., the Globe Union Co. and the Port Washington Station of the Milwaukee Electric Railway and Light Co. Those who took advantage of the trip to Port Washington were very fortunate for this was on Thursday afternoon when the temperature in Milwaukee reached 97 deg. while at Port Washington the thermometer registered only 72 deg. A boat trip on Lake Michigan Wednesday



A 4000 kw. high pressure non-condensing steam turbine upper half cylinder being machined at Allis Chalmers Co. shops.

evening furnished a pleasant interlude from the more serious business of discussing Institute affairs.

Technical Sessions.

So much for the more general features of the meeting. Coming now to the *raison d'être* of the convention the technical sessions covered a wide variety of subjects, extending from discussions on such abstract ideas as Potier reactance to such practical matters as A. C. Motor protection, and demonstrations of new light sources. As is always the case at conventions of this kind, it is difficult to give an adequate picture of the technical material presented. It covers such an enormous range and many of the papers are so highly specialized that the general reader is not interested in many of them. A paper on end connection reactances of electrical machinery such as presented at this meeting by J. F. H. Douglas which is of great interest to the designers of motors and generators is of little or no interest to say, the communication engineer. Certain papers, however, such as the use of oil filled cables on transmission systems, or the description of a new cathode ray oscillograph or a paper dealing with the characteristics of the carbon arc are of more general interest, and in a brief report it is perhaps better to devote attention to this type of paper.

All the above mentioned subjects were discussed. The paper on the new oil filled cable lines in Chicago by Herman Halperin of the Commonwealth Edison Co. and G. B. Shanklin of the General Electric Co. was of general interest because it showed to what extent and with what success a technique used for many years in connection with transformers and circuit breakers had been applied to cable practice; that is, the use of liquid dielectric. It is only a matter of about ten years since the first oil filled cables were installed in this country. At that time an oil filled cable was an innovation and its use was regarded with a certain amount of skepticism. Today, the oil filled cable offers the most complete protection against failure in high voltage operation and its cost of manufacture is continually decreasing. During 1936 and 1937 the Commonwealth Edison Co. is installing four 66 kv. lines consisting of about 100 miles of single conductor oil filled cable. Improvements in the design of these cables, said Mr. Halperin, have contributed substantial reduction in costs. Employing this and other new ideas developed during the past 10 yr., the cost of an oil filled 132 kv. line to have the same carrying capacity as the 1926-27 Chicago line would be only 55 per cent of the actual cost of installation. As was pointed out by Mr. Del Mar at this session, "solid cables can only be made better and better but oil-filled cables can be made cheaper and cheaper."

Of considerable general interest was a paper by Carroll Stansbury of Cutler-Hammer, on the Impulse Operation of Magnetic Contactors. This involved a discussion of the limitations of the ordinary magnetic contactor when subjected to very brief operating impulses. In some instances, as in resistance welding, contactors have to operate on periods of power applications of as short as ½ cycle. Cam operated contactors and also all-electronic controllers have been used in such cases but the magnetic contactor has not been able to enter this field successfully because of limitations which did not permit its use on impulses less than three cycles. These limitations, however, had been overcome by the author by the use of new circuits incorporating thyratron tubes. This development, Mr. Stansbury showed, had been incorporated into a commercial impulse controller in welding service, operating at a speed of more than 5 welds per second.

A development of great interest was announced in a paper by H. P. Kuehin and Sino Ramo of the General Electric Co. at the session on Instruments and Measurements on Wednesday morning. This was a new High-Speed Cathode-Ray Oscillograph. Heretofore, nearly all recording of extremely high speed electrical phenomena has been done by means of what is known as the sealed-in cathode ray oscillograph. This consisted of a high voltage cathode ray oscillograph arranged so that the photographic plate or film could be placed inside the tube, necessitating, of course, the re-establishment of the vacuum after each recording. Although highly successful, the use of these sealed-in units involved many difficulties, especially in securing the proper vacuum after each operation and from time to time other methods have been tried. The most obvious method of merely photographing the luminous trace on the end of an ordinary cathode ray tube from the outside proved too slow for high speed transient phenomena. It was excellent for recurrent phenomena but not for transients of the order of upward of 100,000 cycles per second.

The new oscillograph described, however, is of this type. It is a sealed-glass, high vacuum, hot cathode, tube operating at 15,000 v. and is capable of recording frequencies of as high as 2,000,000 cycles per second.

Another feature of general interest was the interesting demonstration of new light sources by D. W. Atwater of the Westinghouse Lamp Co. Mr. Atwater showed not only the great improvements made in incandescent lamps but also what was being done in the development of new light sources such as the high intensity mercury, the capillary and the ultra-violet conversion types of lamps. Mr. Atwater reported the development of a new high efficiency tungsten filament which will increase the light output of incandescent lamps 10 per cent without any increase in the use of current. This high efficiency filament, which is described in detail on page 479 of this issue, climaxes 24 years of continuous research in lamp development laboratories.

These papers were those of perhaps greatest general interest. The others were of a more specialized nature covering insulation coördination, lightning protective equipment, power transmission operation, mechanical vibration and balance communication and research, etc., and will not be discussed here but all of these papers are presented in various issues of Electrical Engineering, the Institute's regular publication.

As pointed out at the beginning of this report, however, the feature of greatest general interest of this meeting was not so much the technical papers, excellent as these were, but the discussion of the engineer's relation to social and economic welfare.

New officers for the coming year were elected with W. H. Harrison, assistant vice-president, Department of Engineering and Operation, A. T. and T. Co., as president.

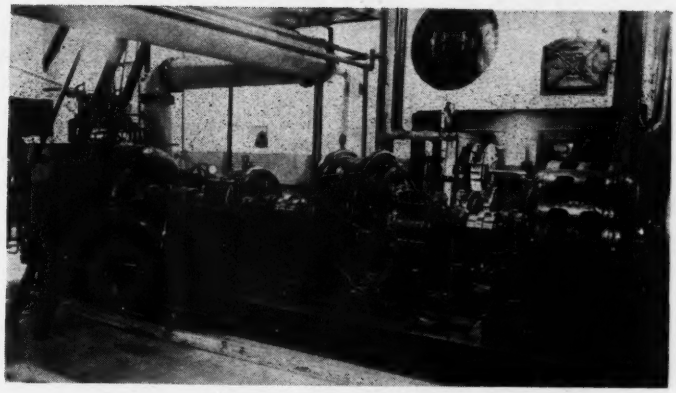


Fig. 1. The combined a.c. and d.c. turbine-generating unit at the Galland Laundry

Anticipating Power Demand Effects Savings in Laundry

By G. K. ANDERSON

KEEPING up-to-date pays, but keeping ahead of business growth pays still larger dividends. This was the experience of the Galland Mercantile Laundry, San Francisco, which recently installed new equipment in their power plant. Equipment which is planned to take care of the growth for at least three years has already justified itself, according to F. B. Abenheim, vice-president.

Early in 1935 a thorough survey was made of the power plant in the laundry having in mind the then reasonable price of boilers, engines or turbines, piping, wiring and all the other materials which go with such an installation. Besides the regular increase of business which could be counted upon, the need for more power facilities in view of the Golden Gate International Exposition, which will be held in San Francisco in 1939, was also taken into consideration.

The survey showed that the power plant is the heart of a laundry. While extra washing machines, pressers or ironers can be obtained within a relatively short time, boilers and electric generating equipment must be ordered months in advance and the changeover imposes inconveniences which are better handled in a leisurely way.

Also, there were, at that time, some rumors of a change in the local electrical rates. On the basis of calculations the indications were that it would be necessary to produce all the electrical energy under stated conditions or to pay a standby on a basis different from that of the former schedule. Careful consideration of these points resulted in the decision to build a new power plant and to make it large enough to carry the load when the floor space in the present plant was completely filled with laundry machinery.

In contemplating an increased laundry business, consideration was given to the necessity for more hot water and the relative merits of engines and turbines. A satisfactorily balanced load in the plant was also of prime importance. It was decided that a properly designed turbine might do the job and studies were pursued along these lines.

The boiler room, when the survey began, consisted of a 400-hp. Badenhausen boiler, a 250-hp. Heine boiler, a 150-hp. Kewanee boiler and a 250-hp. Corliss belt connected to a 200-kw. d.c. generator.

All the alternating current was formerly purchased from a power company. The necessary direct current, which was normally generated in the boiler room and used in the plant and pumping stations, was also purchased whenever the old plant engine-generator set gave trouble or was not in operation.

It soon developed that, to complete the job, it was necessary to have a complete standby equipment so that, in event of a shut-down of the normally used equipment, the plant could still run. As the production of steam ceased at 4:30 p. m. and a night laundry load and pumping load existed, the consulting engineer, Leland S. Rosener, recommended the installation of a Diesel generating set for that load.

When the final plans for the installation were submitted for consideration and accepted, they included the following: One 500 hp. Combustion Engineering four drum-bent tube boiler equipped with and fired by three Coen mechanical register burners, normally burning natural gas with oil equipment interchangeable in a few minutes' time; an Elliott turbine-generator set of 350 kw. capacity, carrying on one shaft both a.c. and d.c. generators and exciter, a used G. E. Turbo-alternator rated at 150 kv-a.; a 120 hp. 6 cylinder Fairbanks Morse Diesel, with direct connected, 75 kw. alternating current generator; a complete new switchboard to interconnect all the generating equipment, and a Simms

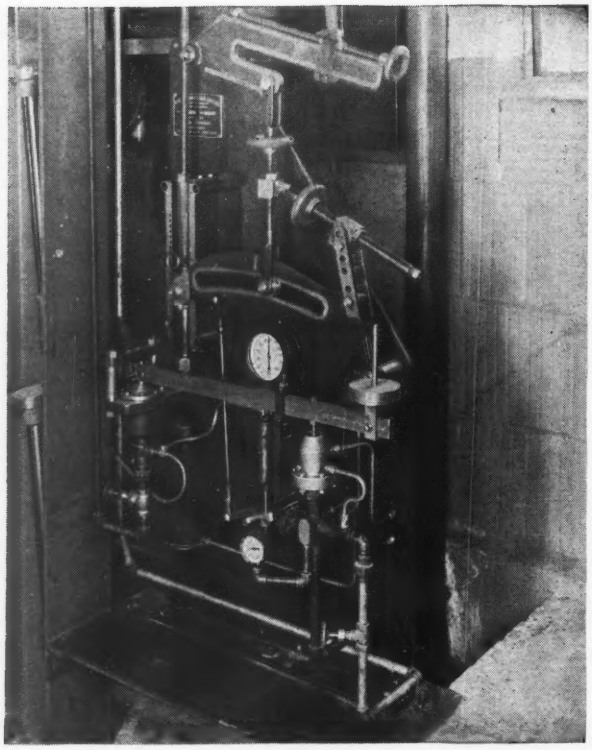


Fig. 2. The Automatic Combustion Control Apparatus

closed type hot water heater using exhaust steam (the condensate being drained back to the boiler feedwater heater) with proper deaerating equipment in the hot water supply line for the laundry.

The boilers are equipped with Brown Instrument Co. recording instruments giving the total steam produced and the temperature of the steam. A Brown Instrument Co. recording CO_2 meter was also installed which gives a graphic record of the combustion performance.

The turbine takes steam at 200 deg. superheat. A desuperheater under a combined recording pressure and temperature control allows steam to be sent into the plant at a reduced pressure and a reduced superheat.

Operation is being carried on with an overall boiler efficiency of 73 per cent and the Elliott turbine generating set has a water rate of 36.33 lb. per kw-hr. at 75 per cent load. It has freed the plant from all outside electrical charges and particularly from a standby charge which would have been greatly increased over the former rate.

An intangible benefit to the plant has accrued since the making of all its own energy. From 175,000 to 200,000 gal. more of water at 130 deg. to 140 deg. each week have been made available than under the previous set-up. As the largest portion of the business is linen supply, where all the material is owned by the laundry, the superior rinsing facilities obtained by this additional hot water will ultimately reflect in large savings.

Results after some months of full operation have proved the move to be well justified. The equipment, cost of building operations and labor, since the purchases were made, have all gone up considerably in price. Besides, the tonnage of the plant, which specializes in linen supply, has increased to a point where the old boiler room equipment, even now, could not have handled it.

The equipment and the firms which supplied it include a boiler installed by the Combustion Engineering Company, Inc., of New York, N. Y. This is a four drum unit, with 4960 sq. ft. of heating surface and built for a maximum pressure of 160 lb., with an Elesco inter-tube superheater. The turbine was built by the Elliott Company, Jeannette, Pa. It is a 350 kw. normal load, non-condensing turbine, driving a double reduction gear, from 3600 to 1200 r.p.m., an alternator rated at 150 kw. 80 per cent P. F. (187.5 kv-a.), 240 v., three phase, 60 cycle, and a 200 kw. d.c. generator.

The standby turbine was made by the General Electric Co. The generator is 150 kv-a. Westinghouse, three phase, 60 cycle, 240 v., 1800 r.p.m. The Fairbanks-Morse Diesel engine is 120 hp., 6 cylinder, with a 75 kw. generating set, 240 v., 4-wire, three phase, 60 cycle, 50 deg. temperature rise. The heater, made by the Simms Heater Co., has a capacity of 300 gal. a minute, one pound steam pressure, 60 deg. to 185 deg. F. rise, maximum working pressure 100 pounds for water and steam. Simons Machinery Co. supplied the 3-inch Deeming 1700 r.p.m. bracket pump.

The combustion control Byrne Automatic instruments, made by the Brown Instrument Co., include a Brown recording and integrating flow meter with temperature recording pen, and Brown electric CO_2 recorder.

Atwood and Morrill supplied the 4 and 6-in. relief valves. A Hays inclined draft gage is used. The pipe, valves and fittings were supplied by Crane Company, and the switchboard was built by the Westinghouse Electric & Mfg. Co.

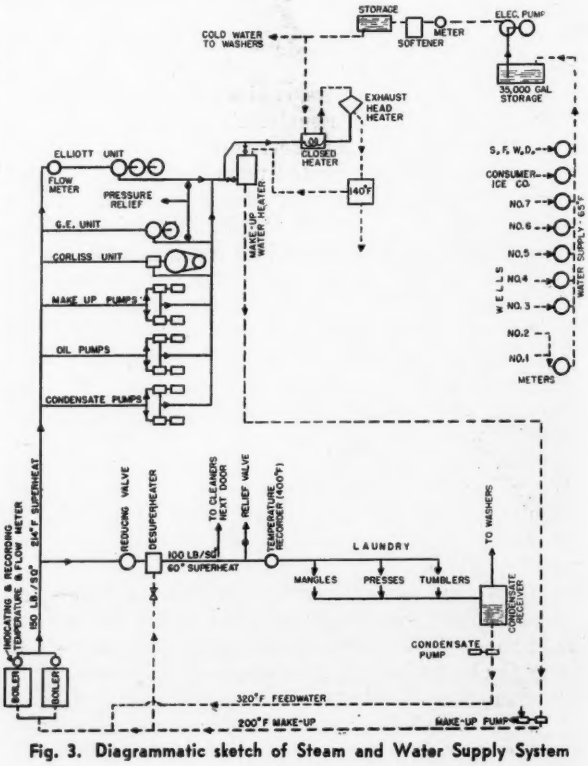


Fig. 3. Diagrammatic sketch of Steam and Water Supply System

Safety in Elevator Operation

A discussion of the more important details that must be looked after by the operating engineer

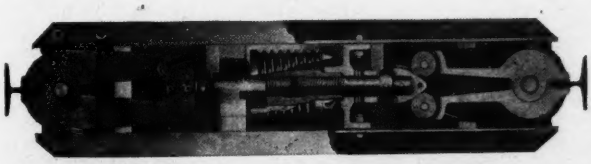
By C. C. CUSTER

IN THE ARTICLE under this title in the March issue, we made the point that to secure safety in operation, elevators should be properly designed and built in accordance with A. S. M. E. code specifications and equipped with all the safety devices in accordance with local and state laws. The operator should thoroughly understand his equipment and if it is of inferior design he should understand its weak points in order to prevent possible accidents. There should be frequent inspections, adequate servicing, correct operating routine, and prompt repair in case that is necessary, especially with a view to keeping all the safety devices functioning to prevent accidents.

A list of typical hazards were given so one could get a vision of the possible dangers involved.

It is true that there will be many fewer hazards connected with an elevator of thoroughly modern design, so that the problem will be simplified to merely keeping the equipment in excellent operating condition and attending to the proper operating routine. The trend of modern design seems to require that all shaftways be made fireproof from top to bottom with a pent house at top extending above the roof to accommodate the machinery. If drum or traction sheave of machine is located directly over the hoistway it takes fewer idler pulleys and less cable length for the drive. Car lever control devices are superior in safety to shipper cable control. Car guides in shaftway are now made of steel with wood guides seldom used. Traction drive machines, which first originated 15 or 20 yr. ago, have now almost entirely replaced the drum machine drive in new installations.

It is considered advisable nowadays to have cars made of metal and shaftways solidly enclosed with horizontal-sliding doors entirely enclosing the opening for passenger service. The doors are of metal and windows, if any, are of wire-glass. The above items are to make the shaftway and its fittings fireproof. Probably the greatest advancement in safety of elevator operation came with the invention of interlocks, which make it become impossible to start the car when a shaftway door is open and impossible to open a shaftway door unless the car is at that landing. These interlocks, when maintained in working order, make the car almost fool-proof.



Guide clamp safety showing drum, threaded shafts, wedge cams and clamps

Operating Condition

As an item of prime importance the engineer in charge should at all times be informed as to the condition of the elevator cables.

This means frequent inspection and keeping a log-book of the condition for occasional reference. In this log book should be entered the date when the cables were installed new and the specifications of the cables. With the car floor even with the top landing the vertical distance from the bottom of counter-weights to bottom of pit should be logged when the cables are newly installed and at regular intervals thereafter so that the stretch of the cables can be followed.

Condition of cables in regard to crown wear, number of broken wires per strand, rusting if any, condition of grooves and evidence of slipping if traction drive, should be noted at intervals; all of which will if known enable us to discard the cables and renew them before the factor of safety decreases to where the condition is dangerous, under the standard rules for discarding cables. When cables stretch to where the counterweights are too near the floor of pit the cables must be shortened, for if counterweights land before car stops at the top landing, cables may slacken and jump off pulleys or become crossed on drum, or if it be a traction drive the counterweights may land before the car reaches the top limit switches and the machine may continue to revolve and slip the cables and wear them. When shipper cable control is used the stretch of shipper cable may make it necessary to readjust the stop buttons slightly from time to time.

A typical accident that occasionally occurs in elevator operation is that the car runs into the overhead or runs down and hits its buffers in the pit. A drum type drive may cause the car to run into the overhead if the button on the shipper cable works loose and if at the same time the machine limit stop fails to function. A traction drive machine seldom runs into the overhead because the clearance is maintained such that the counterweights will land first and then the cables will become slack so that they will slip in their grooves and be unable to drive the car into the overhead. As machine limit stops cannot be used with traction machines we find these machines equipped both at top and bottom with limit switches which are opened when the car overruns, thus setting the brakes. Limit switches are often added as a further refinement to drum machines.

Limit switches should preferably be mounted on metal supports and the contacts enclosed in dust proof box. I have found several cases where limit switches mounted on wooden boards failed to be operated by their cams because the wood had warped.

When Car Hits Buffers

The cause of cars running onto their buffers in the pit is generally due to the failure of the machine brake to function properly. If the brake is misadjusted, if there is oil on the brake surfaces, or if the car is overloaded, this may happen. Sometimes the worm and gear is not properly packed and the oil runs out on the shaft and gets into the brake.

High speed cars are generally equipped with a slow down auxiliary switch which engages at about the second floor landing and helps to lessen the speed of the car as it approaches the lower landing. When a car hits its lower stops it opens its lower limit switch so that the engineer must know how to inch the car up from the pit by operating it from the board.

When an accident of this kind occurs it is always the part of wisdom, before attempting to operate the car, first to see that none of the cables have jumped off their pulleys and that the cables are in their proper grooves on the drum. Another thing that may tangle up the cables and may cause serious damage is the accidental setting of the under-car safety while the car is being operated. All cars are supposed to be equipped with what is called a slack cable safety. This may be either a stirrup under the drum which is operated by a slack cable touching it and completing an arm and lever connection with the control to turn it off, or it may be an electric switch circuit which may be operated in the same way,—or the switch may be operated by the speed governor, or it may be situated at the car beam or under the car and operated by the same mechanism that sets the under-car safety. The engineer should study the location and function of all these safety devices as through neglect some of these may become inoperative.

Under-Car Safety

Probably the most important safety device is the under-car safety which keeps the car from falling in case it overspeeds or the cables break. In general there are now used only two types of safeties—the instantaneous safety and the drum-and-clamp type, which operates more gradually, taking from 6 to 10 ft. of drop to complete its operation and which if in perfect operating condition will bring the car to such a gradual stop that it cannot be told by the occupants from a regular car stop. The instantaneous type of safety stop cannot be satisfactorily used with speeds materially above 100 ft. per min. as it will, at too high speed, throw the passengers on the floor at such a quick stop.

At the present time the drum-and-clamp type of safety seems to be the summit of excellence for high speed cars, although nearly all low speed and push-button cars have the roller-grip type of instantaneous safety in use. A view of the drum-and-clamp type of safety is shown herewith. Some parts of these various safety devices may deteriorate from disuse and want of attention to such an extent as to become inoperative in case they are not looked after by the engineer, as for instance,—we recently found a case where the right-and-left screws of a drum-and-clamp type of safety was allowed to gum up and rust fast so, when the attempt was made to set the safety, there was so much friction that the actuating cable pulled out of its socket instead of operating the screw.

This emphasizes the fact that the drum-and-clamp type of safety should be operated by hand every six months or at least yearly in order that any excessive friction may be noted and be removed by properly lubricating the screws. The drum may be revolved by taking up the plate in the car floor and using the key provided for that purpose. We must explain here that the screws are usually made of gun-metal or phosphor-bronze to obviate rusting. Also the danger of rusting of under-car parts may be minimized at all times by keeping the pit entirely dry of water.

Another case recently found of an inoperative safety device was a case where that part of the speed governor which carries the governor cable clamp was found inoperative because the attendant had painted the fly-balls with red enamel paint and some of the paint had dripped off the brush and got into a bearing and froze it fast.

An obvious way to detect a condition of this kind would be occasionally to pull out the fly-balls by hand to their limit of travel to see that the safety cable will be properly gripped.

In several municipalities there are local ordinances requiring the twice-yearly setting of safeties by overspeed or by throwing in the safeties by hand operation of governors of all passenger elevators. The speed governors may be manipulated by hand to set the under-car safety at the ordinary car operating speed. This procedure will at least discover whether the device will function.

Metal Guides

We have mentioned that metal guides are now used almost exclusively. The types of safeties used with wooden guides generally in operation are inclined to splinter up the guides when they set.

There is another trouble that may also arise from the use of metal guides that may need attention,—when, for instance, a roller grip safety sets, it leaves a burr on the guides, that is, it ought to leave a burr on both guides about equal. These burrs should be removed by a flat file to keep the burr from wearing the car guide shoes. The two roller grips on opposite sides of the car should be set to engage at exactly the same time otherwise one of them will be standing all the brunt of the service. Also it is important that with the drum-and-clamp type of safety, the clamps at both sides engage the guides at exactly the same time. It is also necessary that the car guides be kept set up closely enough so that the wear occurs on the car guides and not on the safety clamps.

It is not possible in one short article to treat of all the things that ought to be looked after in an elevator installation but the engineer who thoroughly understands the functions of all the various safety devices will obviously note things that need attention. A study of the A. S. M. E. Code on elevators will disclose any details of the design that are weak. For instance, we recently noted an installation where a shipper cable drum belted type elevator had its motor changed to alternating current three phase operation, having been previously driven by a direct current motor. When a.c. three phase operation is used, we pointed out to the owners, it is necessary according to code to have an open-phase and reverse-phase relay in the circuit to take care of the contingency that is possible to arise of phase reversal or phase failure that might wreck the apparatus.

Municipal Hydro System

After Several Years' Litigation, Allegan, Mich., Completes Distribution System. 1700 kv-a. Power Plant on Kalamazoo River Completed with P.W.A. Funds

Fig. 1. Night view of the dam, which, with six Tainter gates, fishway and power house measures 220 ft. between retaining walls both of which are visible under the extreme end lights

UNDER THE BOARD OF PUBLIC WORKS, Douglas Alcock, Manager, the new municipal distribution system of the city of Allegan, Mich., was put into service last fall, serving about 800 of the 1200 prospective customers. Completion of the system was delayed several years by litigation arising from the fact that the city was already served by the Consumers Power Co. which owns a 900 kw. hydroelectric plant near the city.

The new system is served with power from a new hydroelectric station on the Kalamazoo River about 5 mi. south of the city. This plant, designed by Ayres, Lewis, Norris & May of Ann Arbor, Mich., and built by The Hay-Weaver Co., has a total capacity of approximately 1700 kv-a. in two units with space provided for a third. The two Leffel wheels, operating under a normal head of 16 ft., drive General Electric 3 ph., 60 cycle, 4800 v. generators, one rated at 563 and the other at 1125 kv-a.

Switchgear, cubicles and transformers are Westinghouse. The generator voltage of 4800 is stepped up to 24,000 by three 133 kv-a. single phase transformers for transmission to town and is distributed at 2400 v.

Typical sections and general layout of the dam are shown by Fig. 1. Earth embankments with a slope of 2:1 downstream and 3 to 1 upstream extend on the east and west sides of the concrete dam. The concrete section of the dam, 220 ft. between retaining walls, is made up of six Tainter gates, a 4 ft. fishway and log sluice and the power plant structure which extends 13 ft. into the west embankment.

A concrete apron on the upstream face of the dam extends down to elev. 591, 25 ft. below normal water level and is sealed off by steel sheet piling 20 ft. long. Below this concrete apron, and along the water line of the earth embankment the rubble paving is used. Both the dam and power house rest on wooden piling cut off at varying elevations from 10 to 20 ft. below the tailwater level. The tailrace and spillway drops are sealed off by sheet piling 10 ft. long. Across the top of the dam is a 20 ft. highway bridge which replaces an older bridge a few yards downstream. This older bridge has since been removed but one of the piers is visible in Fig. 2 just to the left of the power house.

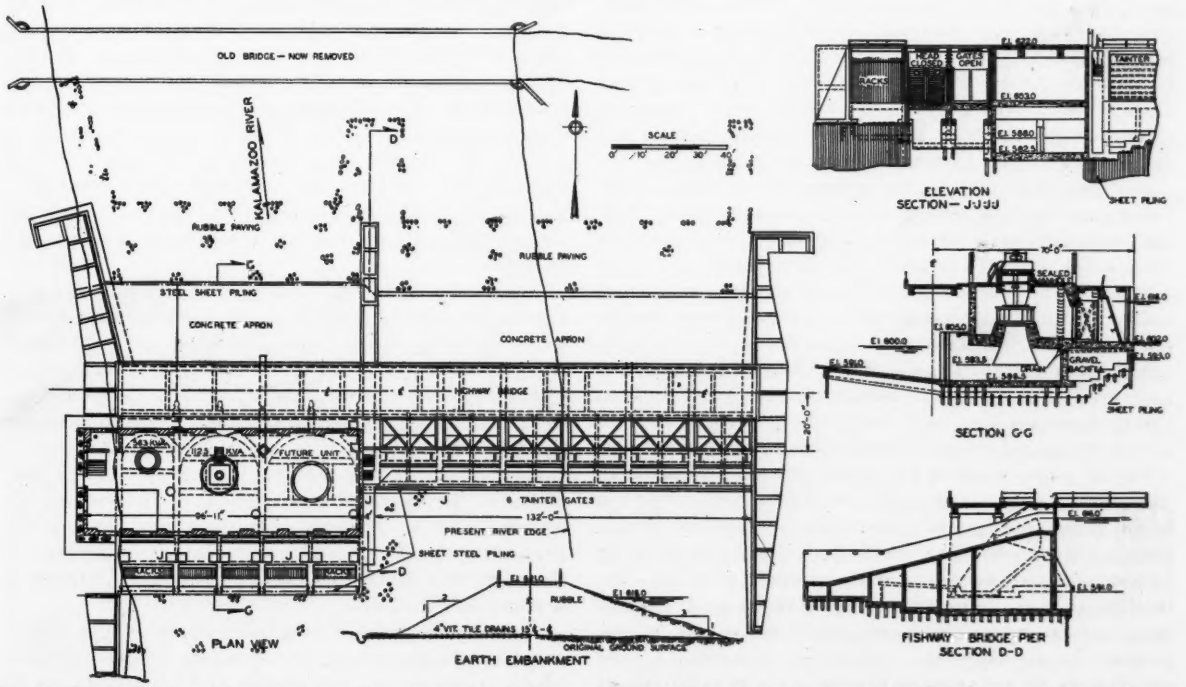


Fig. 2. General layout and typical cross sections of the city of Allegan Municipal hydroelectric plant on the Kalamazoo River about 5 mi. south of the city

Construction and Characteristics of Non-Metallic Gears

Photo courtesy Synthane Products, Inc.

Fig. 1. Group of non-metallic plastic gears

Plastic materials have found favor in many gear applications because of their quietness of operation, light weight, ease of lubrication and resistance to corrosion

By J. DELMONTE

NON-METALLIC gears of laminated plastic have appeared on certain power transmission drives with surprisingly good results. These gears are products of the much heralded plastic materials, which have been an outstanding factor in the development of insulating parts for electrical and radio equipments. Certain of these plastics have superior strength characteristics, and from this group are selected those materials that comprise non-metallic gears.

The plastic material is essentially a solid, organic compound, the phenol-formaldehyde resin being used most widely. When combined with various paper or canvas bases, the well known physical properties are arrived at. In the present day non-metallic gears, textile bases are employed; the coarse, heavy canvas base being used for the larger and heavier duty gears. The canvas sheets are impregnated with phenol-formaldehyde resin, cut into sections and placed one on top of another. The pile of impregnated sheets are pressed under high pressures at elevated temperatures, resulting in a solid, infusible mass, known to the trade as laminated plastic. Typical trade names for this material are: "Insurok", "Micarta", or "Synthane". From these products are cut the gear blanks, from which are machined the gear teeth. In certain smaller types of gears, a molded product (to final form) may prove less costly and equally as satisfactory. For the large gears and pinions, however, a machine job is usually involved. The laminated plastic is entirely homogeneous throughout its structure, though for thicker sections, longer curing periods and greater care are necessary to insure uniformity. It is not possible to separate the individual laminations, and shear tests do not necessarily indicate separations of the individual sheets. Laminated plastic is furnished in thicknesses up to several inches, and any width of gear face desired, may be obtained.

With the above background of the nature and origin of non-metallic gears, it is possible to consider further applications. One of the undesirable characteristics of the majority of metallic gears is the prevailing noise during operation. As the gear teeth become worn with age, this noise becomes more troublesome. The appearance of dirt or grime in the lubricant does not help the condition any. Plastic gears have earned the title of noiseless gears, even after prolonged service, as their outstanding characteristic is quietness of operation. This quietness of operation has made them popular in certain power drive installations, for the minimization of noise works to the psychological advantage of industrial efficiency. Long experience has shown that the worker will do his job better in a quieter environment.

From the viewpoint of costs and performance characteristics, plastic gears have been superior to metallic gears in many cases. This fact has been particularly true for those gears that are not easily lubricated, or else, lose their lubricant rather easily. The lubricant for plastic gears (or bearing surfaces) is water, and not the oil or grease required for metallic gears. As the surface of the plastic material absorbs a small amount of water, the situation is alleviated, as little or no maintenance will be required. On the other hand, plastic gears are not affected adversely by oil or grease. Of these organic lubricants, only a very small percentage is absorbed, if at all.

For heavy duty, power machinery, it has usually proved more economical to use a cast-iron center, about which is placed the plastic rim and gear teeth, in lieu of an all plastic gear. An example of this is in the

bevel and spur pinions, illustrated herewith, manufactured of "Insurok". In the operation of this particular equipment, the non-metallic gears have outlasted the plastic gears quite decisively. Similar plastic gears may be found on other power equipment, particularly where corrosive atmospheres exist. The plastics are resistant to chemical attack and corrosive atmospheres, unlike the metals which are subject to destructive corrosion. This freedom from deterioration is of cardinal importance in figuring the depreciation of materials and the component parts of machinery that they comprise.

Physical Characteristics

In the selection of plastic gears, it is helpful to examine the physical characteristics of the materials that are employed in the construction. High impact

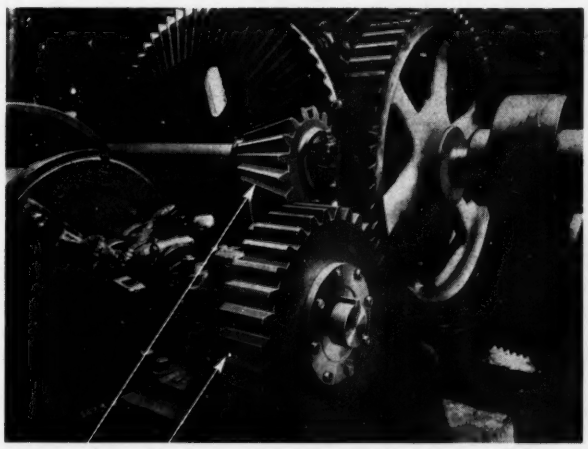


Photo courtesy The Richardson Co.

Fig. 2. Bevel and spur pinions installed on 132 in. board machine back drive

strength and high tensile strength are two prime requisites. The requirement of high impact strength limits the choice of plastic gears to those with a textile base, as they are outstanding in this respect. Approaching these, however, in impact resistance are the molded plastic, shredded fabric filler, used sometimes to mold the gears the final form. The compressive strength of laminated plastic, canvas base, phenol-formaldehyde resin, is in the neighborhood of 38,000 lb. per sq. in., with a tensile strength of 10,000 lb. per sq. in. While these values do not compare with the cast iron or steels, on a strength basis alone, they are better appreciated in a strength-weight ratio. The plastic materials have a density of about 1/6 of iron, so that on a weight basis alone, the plastics are stronger than a large number of steels. The modulus of elasticity of the plastics is rather low, which signifies that they will deflect under load, considerably more than metals. This fact has been used to explain the noiseless operation of plastic gears, as there is a better absorption and distribution of impact stresses that give rise to the noise.

In assuming at least a partial success in the efforts to reduce industrial noises to a minimum, one should be in a position to eliminate one of the most flagrant violators in heavy power machinery.

Coal Utilization

Survey reveals hand fired plants are most numerous, stoker-fired plants use most coal

IN AN address before the Coal Mining Convention of the American Mining Congress at Cincinnati, J. E. Tobey, manager of the fuel engineering division of Appalachian Coals, Inc., gave an interesting summary of the results of survey and research conducted by his organization on the use of bituminous coals. Study of coal-burning plants reveals that hand-fired plants are greatest in number but of small size, average 107 hp., and burn 20.8 per cent of the total coal used in industrial plants. Underfeed stokers are next, about half the number of hand-fired plants, but averaging over twice the size and burning 48.1 per cent of total coal. Overfeed stokers number some 12 per cent as many plants as underfeed, sizes being nearly the same and account for 4.6 per cent of total coal. Traveling grates are some 6.5 per cent of underfeed stokers but average 1.6 times the size and burn 8.9 per cent of total coal. Pulverized fuel plants are in number about 5 per cent of underfeed plants but average 2 1/3 times the size and use 16.4 per cent of the total coal. Spreader stokers, overfeed plants and use 1.2 per cent of total coal. These are average figures and apply only to industrial plants. In coal burned per year per rated boiler horsepower, pulverizers come first, chain grates next, then spreader stokers, underfeed, overfeed and hand-fired.

Since the underfeed stokers were found to be the largest coal users in the industrial field, study is being made of conditions of their operation. It seems, from the results: That coal consumers have little accurate knowledge of the characteristics of coals from various coal seams; that coal salesmen seldom understand a customer's specific fuel requirements; that buyer and operating engineer do not coöperate well; that what seems breach of honesty is often lack of knowledge on the part of both buyer and seller; that price rather than suitability of fuel often governs coal purchasing; that shortcomings of fuel-burning installations limit the range of coals suitable for a plant; that trouble from clinkers is universal. Other sources of unsatisfactory coal utilization are: Coal substitution by jobbers; poor use of available knowledge as to coal selection; variation in coarse and fines in coal; segregation of coarse and fines in handling and firing; frequent changes in coal used; mixing of different coals.

As means to overcome these difficulties, Mr. Tobey concludes as important that, as coals are sensitive and little can be done to change their characteristics, firing equipment should be designed to improve combustion, to reduce the minimum ash fusion tolerance and to be ruggedly flexible. In most industrial plants, firing equipment is obsolete and should be replaced with modern design. Fuel engineers should be utilized to spread knowledge among coal users, to insure that knowledge of coal burning essentials is applied and to arouse interest in fuel engineering and in the results of research on coal utilization.

CLARK'S FALLS Hydroelectric Development

By L. G. Ropes
Designing Engineer
CHAS. T. MAIN, INC., BOSTON

THE PUBLIC ELECTRIC LIGHT COMPANY of St. Albans, Vermont, is building a new hydro-electric plant at Clarks Falls on the Lamoille River at Milton, Vermont.

This is the third hydro-electric plant to be built on the river by this company. The plant at Fairfax Falls, built in 1919, located about 8 mi. above the new plant, contains two 2000 hp. units operating under 80 ft. head. The present plant at Milton, built in 1929, is located about 2500 ft. downstream from the new plant and contains a 4500 hp. unit operating under 95 ft. head with provision for a second unit of the same capacity to be installed later.

The new dam at Clarks Falls will provide a large amount of storage and will greatly increase the dependable power at the present Milton plant. The area of the pond when full will be about 350 acres. About 200,000,000 cu. ft. of water will be impounded.

The concrete section of dam is about 400 ft. long, with a maximum height of 40 ft. At the south end there will be an earth fill dike about 450 ft. long with a maximum height of 20 ft. The dam will raise the water level about 28 ft. and will make necessary the relocation of about 4000 ft. of concrete highway at the northerly end of the dam.

The dam is designed to safely discharge a flood in excess of the November, 1927, flood, or about 85,000 cu. ft. per sec., with a rise in the pond level of only 2 ft. above normal. It has three taintor gates, each 24 ft. wide by 23 ft. 6 in. high, and four sections of stanchion flashboards 42 ft. 6 in. wide by 20 ft. 6 in. high. There is also a free overflow spillway 100 ft. long.

A bridge extends over the taintor gates and stanchion flashboard sections, supported on the piers which separate the sections. The stanchion flashboard sections consist of steel beam stanchions about 5 ft. on centers, supporting the flashboards. The upper ends of the stanchions are supported from the bridge by a latch which can be easily and quickly released by a trigger arrangement.

The three taintor gates will discharge a flood of about 30,000 c.f.s., which is in excess of any flood on record except the 1927 flood. It is expected that none of the stanchion flashboards will have to be released except on rare occasions, and no provision has therefore been made to save the stanchion beams.

Each taintor gate is operated by a 25-t. hoist located on the adjacent pier. The hoisting drums are mounted on a 14-in. diam. seamless steel tube which spans the opening between piers.

One of the taintor gates is operated by remote con-

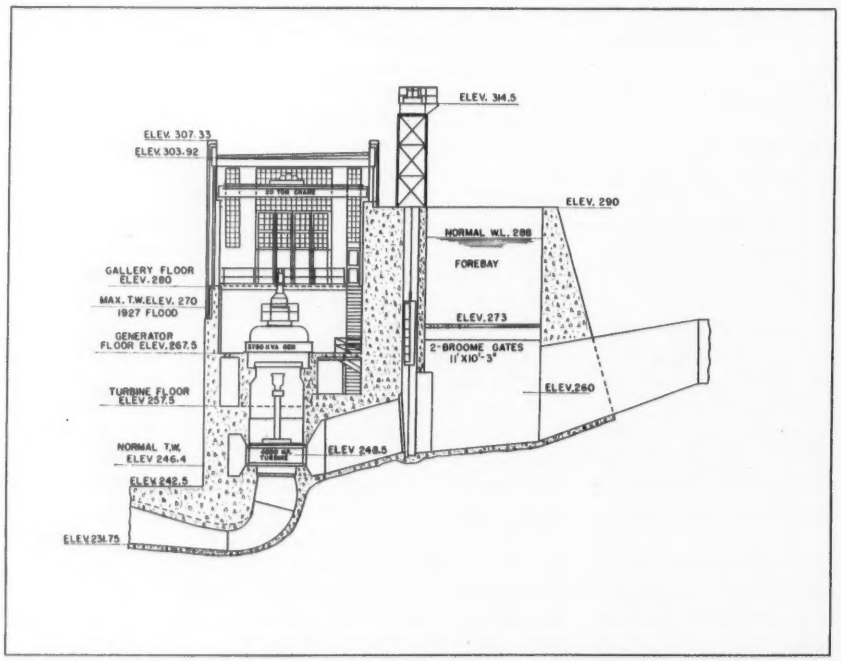
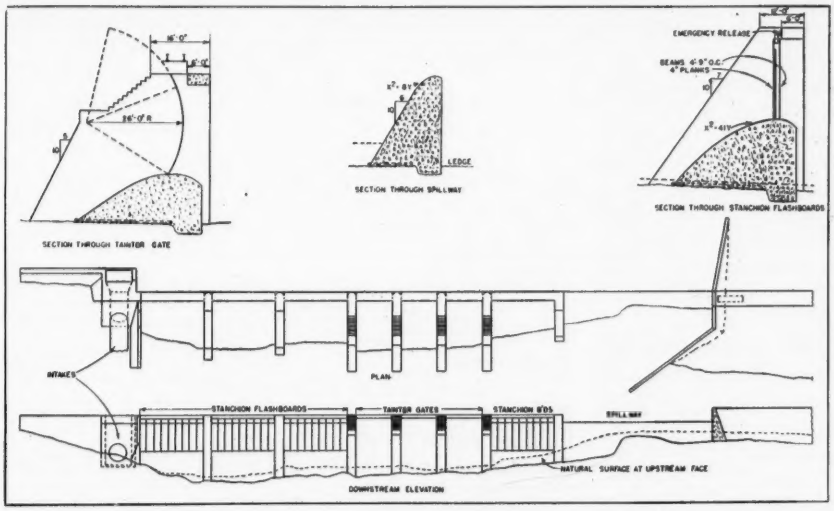


Fig. 1. Cross section through power house and forebay. The power house contains a 4000 hp., 240 r.p.m. 41 ft. head, Kaplan type turbine direct connected to a 3000 kw., 2400 v. 60 cycle, 3 phase, 240 r.p.m. vertical generator with direct connected exciter. This unit will be under remote control from the company's Milton plant



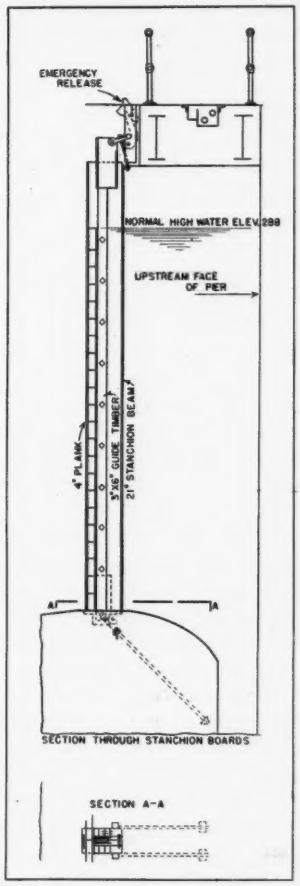
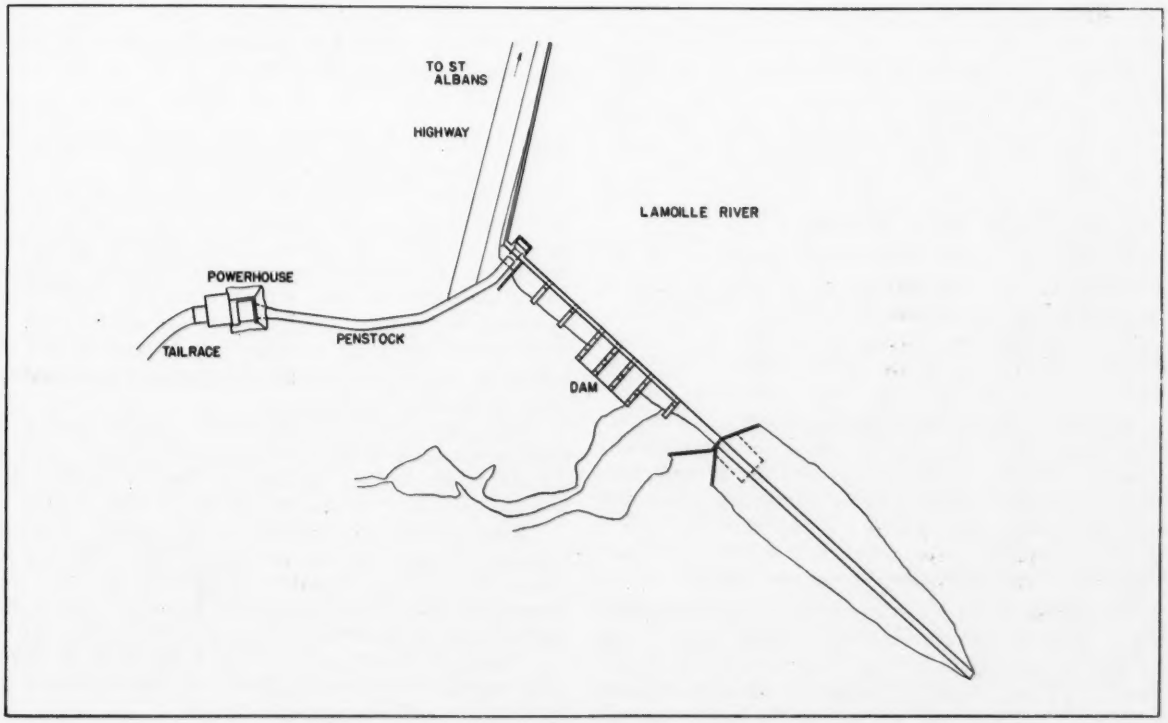


Fig. 2. General details of the dam, showing sections through the taintor gates, the stanchion flashboards and the spillway. Fig. 3. Section through the stanchion flashboards showing latch at upper end by means of which the stanchion flashboards can be released in extreme emergency. Fig. 4. General plan of the entire development showing the location of the dam and power plant. The dam has three taintor gates, each 24 ft. wide and four sections of stanchion flashboards 42 ft. 6 in. wide. There is also a free overflow spillway 100 ft. long. This dam impounds about 200,000,000 cu. ft. of water



trol from the power house of the Milton plant. A position indicator will show the position of the gate. A water level indicator is also provided at the Milton plant to show the Clarks Falls pond level.

Electric heaters are provided along the sides and the bottom of the taintor gates to prevent freezing. At the sides these are installed in a steel box set in the face of the concrete pier. The heaters at the bottom are installed in a box formed in the bottom of the gate. The total heater capacity provided is 18 kw. per gate, 6 kw. on each side and 6 kw. at the bottom. These are arranged so that they can be operated in three stages of 1½, 3 and 6 kw. each set, depending on the temperature.

Compressed air is provided to agitate the water in front of the taintor gates, stanchion flashboards, and intake to prevent freezing. The air is supplied from an air compressor having a capacity of about 100 cu. ft. of free air per minute, located in a small house at the end of the dam.

The receiving tank is located in the same room with the compressor, and the air will then be immediately conducted through pipes laid in a trench in the bridge floor and insulated with asbestos pipe covering. The air pipes lead down through the bridge piers and connect to headers on the upstream face of the dam immediately below the bottom of the stanchion flashboards and taintor gates. The nozzles are located about 6 ft. on centers. In this way the air which is heated from compression retains its heat until it is liberated at the nozzles and it is anticipated there will be no trouble from freezing of the air pipes due to moisture in the air.

Steam is also provided for removing ice around the taintor gates or stanchion flashboards in case of emergency. The steam is supplied by a boiler with oil burner, located in the basement of the compressor house, through piping in the same pipe trench with the air piping, to hose connections located at intervals.

At the northerly end of the dam there is an intake to a 12-ft. diameter riveted plate steel penstock which will be 400 ft. long, ending in an open forebay provided with a free spillway. There are no gates at the intake, so the penstock will always be full and will not need to be anchored to overcome possible uplift during a flood, when the penstock will be submerged.

The forebay is provided with a concrete slab just above the top of the penstock with a restricted opening designed to dampen surges and improve regulation.

Two broome gates are provided in the forebay, motor operated by remote control from the Milton plant.

The power house will contain a 4000 hp., 240 r.p.m., 41-ft. head, Kaplan type turbine with automatically adjustable blades, direct connected to a 3000 kw., 2400 v., 60 cycle, 3 phase, 240 r.p.m., vertical generator, with direct connected exciter. This unit will be under remote control from the company's Milton plant, and no operator will be required in the new plant.

The power house is designed so that the equipment can be kept in operation during a flood greater than the 1927 flood, concrete walls being carried above the flood level without doors or windows, and a sump pump provided to handle any seepage. The generator will be set below the flood level to reduce the length of shaft, but a landing floor will be provided above.

A feature of the power house, and one which is new in power house construction, is the use of glass brick in the superstructure instead of the ordinary steel sash windows. An attractive exterior is obtained by using the glass brick in large panels with tall brick piers between the bays. Vertical lines are emphasized to increase the apparent height of the superstructure, to offset the height of concrete substructure made necessary by flood requirements.

A system of air ducts will supply the generator with cooling air from outside of the building, and will also discharge the heated air outside. The intake and discharge openings will be located above flood level.

These ducts are provided with motor operated louvers arranged so that the outside openings may be closed during cold weather and warm air from the generator used to heat the powerhouse, the air in the powerhouse being recirculated through the generator.

The development was designed by Chas. T. Main, Inc., engineers of Boston, Mass., to whom we are indebted for this description.

List of Principal Equipment in the Clark's Falls Hydro-electric Plant

Turbine equipment—S. Morgan Smith Company.
One 4000 hp., 240 r.p.m., 41 ft. head, Kaplan adjustable blade turbine.
One Lombard oil pressure governor, 35,000 ft.-lb. capacity, with automatic accessories.

Generating equipment—General Electric Company.
One 3750 kv-a. (3000 kw.), 240 r.p.m., 3 phase, 60 cycle, 2400 v. generator, with direct connected exciter.

Switchgear and lightning protection equipment—General Electric Company.

Wiring done by owners.

Transformer—3 phase, 3750 kv-a., air pressure cooled —General Electric Company.

Power house crane—20 t.—Shaw-Box Crane & Hoist Co.

Storage Battery—Exide.

Broome gates and control equipment—Philips & Davies, Inc.
Two 10′-3″x11′-0″ gates with 20 t. hoist.

Penstock—fabricated by Bethlehem Steel Company and erected by the general contractor.

Taintor gates—Philips & Davies, Inc.
Three gates, 24′-0″ long by 23′-6″ high.

Three 25-t. Taintor Gate Hoists—S. Morgan Smith Company.

Air compressor at dam—air cooled, capacity 117 cu. ft. free air per minute,—Worthington Pump and Machinery Corp.

Electric heaters for taintor gates—Hynes Electric Heating Co.

Sump pump in powerhouse—Goulds Pumps, Inc.

The work is being carried on under the general direction of A. W. Peterson, manager of the Public Electric Light Company.

The general contractor on construction is P. E. Sullivan of St. Albans, Vermont.

The development was designed by Chas. T. Main, Inc., Engineers, of Boston, Mass.

Duplex Alinement Rule

By FRED J. WIEGAND

NEED for an alinement rule which could be used for direct reading of alinement charts constructed for the solution of equations involving four or more variables has been apparent for some time. It is believed that the duplex rule here described fills this need. It consists of two celluloid rules, or legs, joined by a movable pivot. The upper leg, containing the slot, is thickened at each end a sufficient amount so that the lower leg can be moved to various positions independently of the slotted leg.

This lower, or solid, leg has an aluminum rivet fastened at its center which is free to slide in the slot of the upper leg. Each leg carries a black index line on its under side, the one on the upper leg being placed off center to clear the slot and rivet. The intersection of these lines can be made to take place at any point within the limits of the slot. Either leg can be used as a single rule for reading charts constructed for solving equations of less than four variables. A general view of the rule is shown in Fig. 1.

Alinement or nomographic charts are frequently used in engineering work to replace numerical computations. They consist essentially of a set or family of scales so constructed and arranged that any straight line (index line) drawn across these scales will cut them in points corresponding to their values in some particular equation.

The usual method of drawing the straight line from scale to scale is to lay across the scale a strip of celluloid which carries a black line on its under side. When this line cuts two of the scales at the proper points, it will cross the third scale at the correct value.

This is satisfactory for a chart based on an equation containing but three variables, but for an equation of four or more variables the chart must contain a "turning line" or intermediate value. For a chart of this kind the single strip or rule of celluloid must be used in two different positions. Consider a chart based on the formula $\frac{AB}{C} = D$. This chart would be constructed so that the index line joining the variables A and B and the index line joining the variables C and D would have to intersect on the turning line. If the values of A, B, and D are known, the rule is placed so that the index line cuts the A and B scales at the correct points. At the intersection of this index line with the turning line it is necessary to hold a pencil or mark the turning line. This intersection is maintained and the rule again placed so that it cuts the scale D at the proper point. It will then intersect the C scale at the required value.

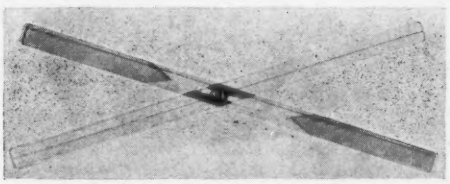


Fig. 1. Rule for duplex alinement charts

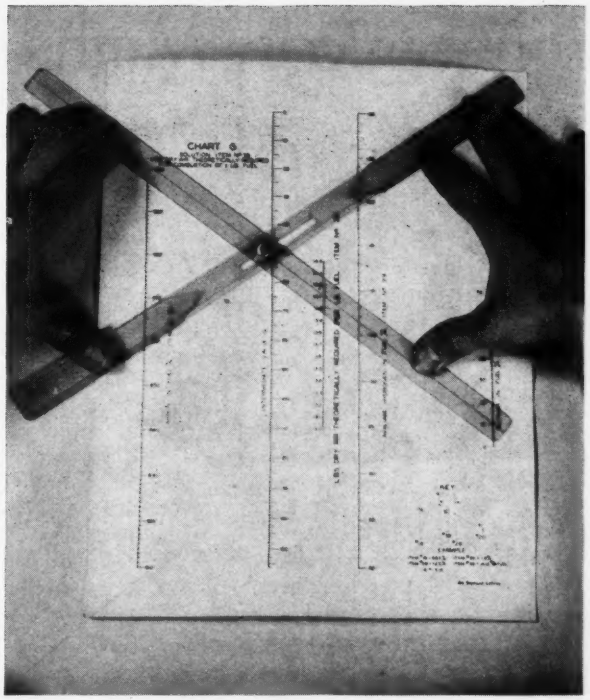


Fig. 2. Using rule for solution of problem with four variables

From this it is seen that there is a possibility of error, since it is impossible to mark the turning line until after the rule has been removed. In order to check the mark it would have to be placed in position again. Some charts have the turning line divided and marked off as a scale. Placing a scale on the turning line, however, is sometimes confusing. Also, it is necessary to interpolate between its divisions to secure a reading and to replace the index line. This leads to some inaccuracy.

These disadvantages are overcome by using the duplex rule described above, so that both positions of the index line can be obtained simultaneously. For a four-variable chart, and working the example given above, place the upper leg of the rule containing the slot in such a position that its index line cuts scales A and B at the proper values and so that the slot crosses the turning line. Holding this part of the rule in place, move the lower leg in the slot until both indices intersect on the turning line and its index line cuts scale D at the proper place. It will then indicate the required value on the C scale. This is shown in Fig. 2.

This duplex rule permits of reading alinement charts containing intermediate values with more accuracy and speed than can be done with a single rule. It is not necessary to mark the turning line or to read its scale, if it has one. In addition, a check can be had on the first two values, since this part of the rule is still in place while obtaining the final reading.

Economical Methods of Blowing Down Boilers

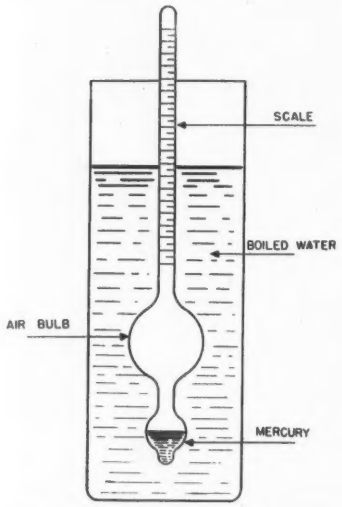


Fig. 1. Common form of hydrometer

Boiler water conditioning by the blowing down process is accompanied by waste of water and heat, but may be minimized by following a careful schedule and employing heat exchangers

By CHARLES L. HUBBARD

WHILE special equipment for the removal of impurities from feedwater before it enters the boilers is frequently found in small and medium size plants, there are still many instances where blowing down the boilers at more or less frequent intervals is depended upon as the only means for preventing too great a concentration of water within them. The impurities removed in this manner consist largely of the carbonates and sulphate of lime and magnesia, which are thrown down when the water is heated to a sufficiently high temperature. Suspended matter, such as fine mud, sand and clay are also present in some cases and tend to settle when agitation of the water ceases. While removal by special heaters, settling tanks and filters is preferable in most cases, both for protecting the boilers and as a matter of economy, the process of blowing down may be greatly improved by placing it on a scientific basis instead of relying upon guess work, as is usually the case.

When not enough water is blown off the water becomes too concentrated, thus tending to produce corrosion and incrustation. On the other hand, excessive blowing down results in waste of both heat and water. The amount of sediment which would collect in a boiler in the course of a year if it were not removed, evidently depends upon the quantity of water evaporated and the amount of solid matter which the feed contains, either in solution or suspension.

Amount of Mineral Matter Accumulated

Assuming 30 grains of dissolved mineral matter, per gallon, which is not at all excessive, the accumulation per year would amount to approximately 40 lb. per boiler horsepower, or 2 tons for a 100-hp. boiler.

The heat lost in the water blown off to maintain a concentration of 300 grains per gallon would call for the burning of about 12 tons of coal and the discharge of approximately 90,000 gal. of water in the same length of time. If the quantity of water were guessed at, without scientific checking, the fuel and water lost might be increased several times without accomplishing any useful results.

It is evident from the above that any process as important as that of blowing down a battery of boilers must be done intelligently in order to reduce the water and fuel wastes to a minimum.

Necessity of Chemical Analysis

In placing this on a scientific basis, and working out a regular schedule, the first step is to obtain a chemical analysis of the raw water, then decide upon a safe concentration to carry in the boilers, and measure the density. These are all matters for the chemist; but after the factors are fixed upon, it is a simple proceeding to determine the quantity of water to be blown off per day and to check up the concentration by means of a hydrometer to see if the desired condition is being maintained.

Using the same assumptions as before (30 grains of solid matter per gallon of raw water and an allowable concentration of 300 grains per gallon), a practical example will show how these data are used.

A 100-hp. boiler will evaporate $(100 \times 30) \div 8 =$ 375 gal. of water per hour, or $375 \times 8 = 3000$ gal. per day of 8 hr. To replace this requires an equal amount of raw water containing $3000 \times 30 = 90{,}000$ grains of solid matter which must be removed by blowing off.

With an operating concentration of 300 grains per gallon, each gallon discharged will carry off that amount of solid matter. Hence, $90{,}000 \div 300 = 300$ gal. of water must be blown off per day to produce the desired results.

In order to simplify the process, measurements should be made to determine how much the water must be lowered in the gage glass from its normal level to remove the computed amount.

When blowing down under pressure great care must be used to secure the best results. The boiler water should be allowed to stand quietly for an hour or two so that the sediment will have a chance to settle, the

valve should be opened and closed slowly to prevent shock, and furthermore, should be fully opened for a few seconds in order to prevent deposits from forming in the blowoff pipe.

As the quantity of steam evaporated, the percentage of impurities in the raw feed, and the volume of water blown off, will vary somewhat from day to day, it will be necessary to check up the concentration from time to time and make such changes in the operating conditions as may be called for to secure the desired results.

Data furnished by the chemist gives the allowable concentration in terms of specific gravity, and this for a sample of boiler water may be read directly from the scale of a hydometer, a simple form of which is shown in Fig. 1.

In order to reduce the heat waste to a minimum various devices are employed, some patented and some home-made. The general principle upon which these operate is illustrated in Fig. 2, and consists in some arrangement of coils or tubes by means of which a portion of the heat contained in the blowoff water will be transferred to the raw feed before it enters the regular heater.

Under average conditions the blowoff water amounts to about 5 per cent of the feed, and is cooled to within a very few degrees of the cold feed entering from the main. Under a boiler pressure of 120 lb., feedwater at an initial temperature of 60 deg. will reach the boiler at a temperature of about 220 deg. when passing through an arrangement similar to that shown in Fig. 2, where the regular heater is of the open type supplied with exhaust steam. By placing a thermostatic valve in the pipe to the sewer, at the point shown, the operation of blowing off may be made practically continuous and entirely automatic.

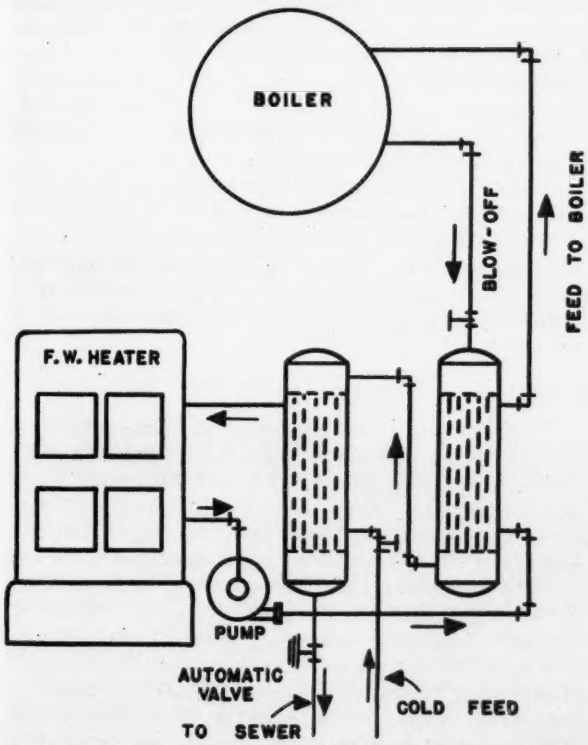


Fig. 2. Diagram of arrangement for reducing waste heat in blowing off boilers.

Condensers Cleaned by Air Drying

UNDER SOME circumstances of operation the tubes of surface condensers under steam turbines become fouled with algae, a moss like growth that adheres to the water side of the tubes, and which is particularly common in either fresh or salt water where there is sewage polution. Various methods of partial sterilization are effective in diminishing the rate of growth of the algae film, but under some conditions the growths do accumulate and cleaning of the tubes becomes necessary. At the Cahokia power plant of the Union Electric Company of Illinois, across the Mississippi from St. Louis, an effective method of removing the algae film by air drying has been developed during the past few years.

For a few weeks late each summer in low water years, algae growths had accumulated to the point where removal was necessary each week. A trial has been made at drying out the film by circulating air through the tubes with excellent results. When completely dry the algae growth shrinks to flat "tea-leaf" flakes, which readily flush out with the first circulating water. The outage for cleaning the tubes of a 60,000 sq. ft. condenser by this method is only eight hours, whereas mechanical methods using eight men require sixteen hours. Furthermore the cleaning is complete. Mechanical scraping had left a thin film on the tube surfaces, and this prompted the rapid forming of a new growth. With the complete removal from the surface of the tubes by drying, new algae growths are slow to form and the interval between cleaning periods has been doubled. Furthermore the average back pressure in the condensers has been improved because of the better heat transfer. Because of the shorter time required to do the job and their lesser frequency the cleaning jobs can be scheduled over week ends when the units are not needed.

The equipment used at Cahokia on four of the five units consists of a 20,000 c.f.m. portable motor driven fan delivering air at 3.5 in. water static pressure to two pass condensers ranging from 50,000 to 56,000 sq. ft. surface. The fan discharge is connected through two 16 inch sheet metal ducts to two open inspection doors at the discharge water box, and the air leaves the condenser through open doors on the inlet box. Drying takes about 8 to 10 hours depending on how thoroughly the tubes drain themselves, and has been further reduced by preheating the air so as to increase its moisture absorbing ability. When drying is complete the circulating water is turned on at maximum flow so as to flush out the dried particles before they can resume growth. The job is then complete.

On a 75,000 kw. unit at the plant the generator air fans are housed separately from the generator, and the discharge from one of these fans can be led through the condenser. Drying in this case can be accomplished in six hours.

Developments in the prevention of failures of surface-condenser tubes in the steam-electric generating stations of The Edison Electric Illuminating Co. of Boston

Prevention of Failures of Surface-Condenser Tubes*

By R. E. Dillon, G. C. Eaton, and H. Peters

SOME 25 yr. ago, in coöperation with the condenser-tube manufacturer who developed the process, tubes of Admiralty metal made by the cup-drawn method were tried out in the surface condensers serving the vertical turbines in the early section of the L Street Station in South Boston. Steam at 200 lb. per sq. in., and 500 deg. F. operate these turbines. The results of the early experiments and developments were very gratifying. Dezincification and consequent tube failures sharply decreased. A large portion of the Admiralty tubes installed at that time are still in service due to developments which will be discussed in this paper.

With the reduction of dezincification, the phenomenon of inlet-end wastage of condenser tubes was made more pronounced. It was noted that this wastage was concentrated within the first few inches. Since the tubes were packed with corset lacing and ferrules, the

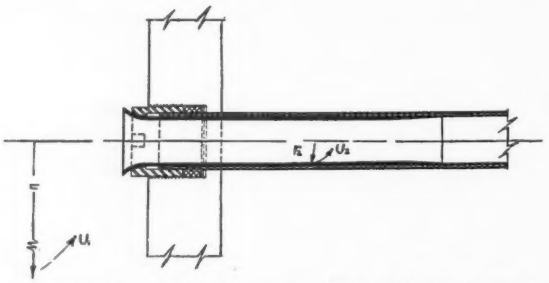


Fig. 1. Bushing Inserted in Tube. Letters Indicate Water-Box and Tube Velocities for Rotating Flow

use of longer or extended ferrules was tried in the hope of confining the wastage to the replaceable ferrule. Moderate success was achieved by this method.

The replacement of extended ferrules, while much cheaper than tube renewal, was nevertheless expensive. The idea of lining the inlet end of the tubes with a bushing which could be easily inserted and readily replaced was conceived and developed (see Fig. 1). An effort was made to conform the inside surface of the bushing to the shape of the vena contracta in order to remove at this point the turbulence and high vacua with consequent air liberation from the circulating water. This turbulence and air liberation were at that time blamed for the inlet-end wastage of the tubes.

The inlet-end bushing was a pronounced success and a major step in the prolongation of tube life. There was but one detrimental effect of the use of the bushings upon the condenser tubes themselves. The tapered or downstream end of the bushing (see Fig. 1) cannot be made infinitely sharp or to fit exactly the inner surface of the tube. As the result of these practical limitations, there is an irregularity or shoulder in the combined inner surface of bushing and tube, *after* which minor tube wastage usually occurs. This effect upon the tube has been minimized by installing subsequent bushings of increased length to cover the slightly wasted portion of the tube. The bushings have invariably required replacement before the tube wastage at this point has become serious.

The problem of tube cleaning when bushings are installed has been successfully solved by the use of bristle brushes six to eight tube diameters long. These brushes are inserted at the inlet end of the tube and "shot" through the tubes by a "gun" admitting a turbulent mixture of water and compressed air behind the brush.

Single-Pass Condenser

The first single-pass condenser to be installed in a Boston Edison station was placed in service in 1927, and soon after it was equipped with bushings. Until this installation, only two-pass and four-pass condensers were in use at the L Street and Edgar Stations. The life of the tubes in these multipass condensers was entirely satisfactory and has continued to be so after the installation of the bushings previously described. The new single-pass condenser required complete retubing in 1932 after but 5 yr. of service. The necessity of this retubing had until the last 2 yr. been attributed very largely to the unsuccessful use of an inferior type of chlorinating equipment for treating the circulating water to inhibit slime formation in the tubes. Subse-

*From a paper presented at the Semi-Annual Meeting of The American Society of Mechanical Engineers, held in Detroit, Mich., May 17-21, 1937.

quent experience with the second set of tubes has shown that undue weight was given to the effect of improperly used chlorine gas on the first set of tubes, although there is no question but that its use materially hastened tube replacement.

Search for Methods of Eliminating Air Liberation

The very early failure of a considerable number of the second set of tubes near their inlet ends but beyond the downstream ends of the bushings caused the engineers to renew their search for causes of tube failure.

In order to observe and to understand more clearly the conditions existent on the water side of the condenser, observation windows were installed in four access doors of the inlet water box together with adequate illumination. Two of these windows were located just above the horizontal center line of the water box and the other two near its top. Observations through these windows showed that in the upper third of the water box there was a highly turbulent mixture of from very large to very small air bubbles and water. Also in this upper third of the water box, for long and for short periods of time and sometimes almost continuously, long ribbons of air surrounded by a spinning mass of air-bubble-and-water mixture would run from the mid-portion of the water box to the tubes.

Attempts to reduce the air liberation had of necessity to be confined to the reduction of minor turbulence in the water box and connected inlet piping, pumps, and intake tunnel. Irregularities in the inside surfaces of these passages were removed or smoothed wherever practicable, the pump impellers and casings were checked for exact alinement, and air leakage at the packings was minimized. The inlet tunnel was vented to insure that no accumulation of air would form near its roof to be drawn at intervals into the pump suction lines. Vertical baffles of various lengths attached to the braces in both inlet and discharge water boxes were tried in an attempt to reduce the surging that was also observed. Two circulating-water pumps were used instead of the usual one to reduce velocities with the accompanying turbulence and air elimination.

These efforts brought little or no improvement in the observed conditions, and tubes failed in increasing numbers. Thus, it became increasingly clear to the engineer that with the existing arrangement of water box, connecting piping, and pumps shown in Fig. 2, no small changes would reduce the air liberation then believed to be the sole cause of the tube failures. Causes other than air liberation were then looked for in the hope of solving the acute problem without redesigning the existing equipment. In this connection the cavitation experiments at the Massachusetts Institute of Technology were investigated.

Cavitation and Corrosion

A study of the location of the tube failures had already indicated that there were two areas where the percentage of tube failures was relatively much higher than in the remainder of the tube bank. One of these was in the upper-left lobe and the other slightly to the right and below the center of the tube sheet, as viewed from the entrance end of the tubes. These locations are indicated in Fig. 3. Also the damage to the individual tubes was found to occur at the end of the bushings and extend a short distance downstream. The bell-mouth entrances to the bushings showed a general thinning nearly equal all over the tube bank, while the divergent part was worn most in the areas of greatest tube failure. The localization of the tube and bushing damage is most reasonably explained as the result of destructive cavitation followed by corrosion. To produce destructive cavitation, the water pressure at a point must approach the vapor pressure corresponding to the water temperature, so that cavities in the water are filled largely with vapor. If the existence condition for the vapor disappears through increase of pressure, the vapor will condense or collapse, and an exceedingly high pressure will occur due to the impact of the water filling the vapor space from all sides. Destructive cavitation on any surface will break tiny particles from that surface thus making pits. These pits are well adapted for the accumulation of oxides and salts beneath which a rapid attack may proceed,

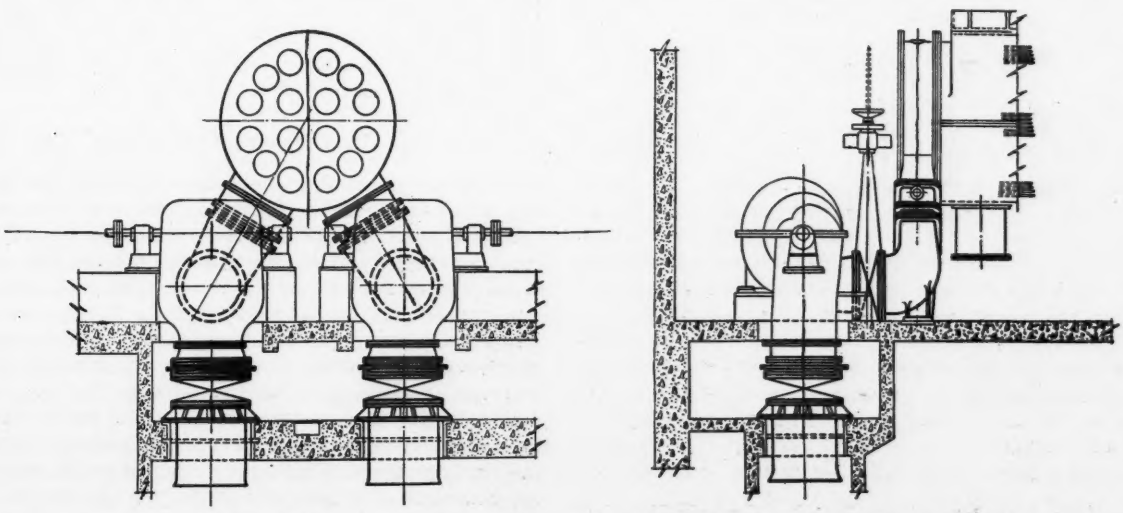


Fig. 2. Single-Pass Condenser with Pumps and Connected Inlet Piping as Installed at the Edgar Station

furthered by the ready supply of oxygen from the liberated air. If this hypothesis, which is readily applicable to a condenser tube, were correct, it would then be desirable to prove the actual possibility of destructive cavitation in the single-pass condenser.

Moody and Sorenson have very definitely proved that cavitation will occur when

$$v_2 = \sqrt{[2g(h_1 - h_2)]} \quad \ldots\ldots\ldots\ldots [1]$$

where v_2 = axial velocity, f.p.s.; g = acceleration due gravity; h_1 = static pressure, ft. of water; and h_2 = absolute vapor pressure corresponding to the water temperature, ft. of water.

If, in a top tube of the single-pass condenser at a low tide, $h_1 = 12$ ft., $g = 32$ f.p.s. per sec., and $h_2 = 0.7$ ft. at 70 deg. F., then the minimum axial velocity v_2 for cavitation to occur will be 26.9 f.p.s. Study of the hydraulics of the condenser show such velocities *axial* to the tubes to be impossible. However, cavitation can easily occur if the water flow in the water box has *tangential* velocity components. Actual observation of the flow had shown tangential-velocity components of appreciable magnitude. The ribbons of air previously referred to were the cores of the vortices and indicated the low pressures existent to release the air.

Referring to Fig. 1 which shows the relative positions of the rotating flow in the water box, a bushing, and tube, the tangential velocities and the radii bear the relation

$$u_1 r_1 = u_2 r_2 \quad \ldots\ldots\ldots\ldots\ldots [2]$$

and Bernoulli's theorem gives the pressure-velocity relation

$$h_1 + \frac{u_1^2}{2g} = h_2 + \frac{u_2^2}{2g} + \frac{v_2^2}{2g} \quad \ldots\ldots\ldots\ldots [3]$$

where u_1 = tangential velocity at r_1 of the free vortex in the water box, f.p.s; u_2 = tangential velocity at r_2 of the free vortex in the bushing, f.p.s; r_1 = radius of the vortex in the water box, ft.; and r_2 = sectional radius of the bushing, ft.

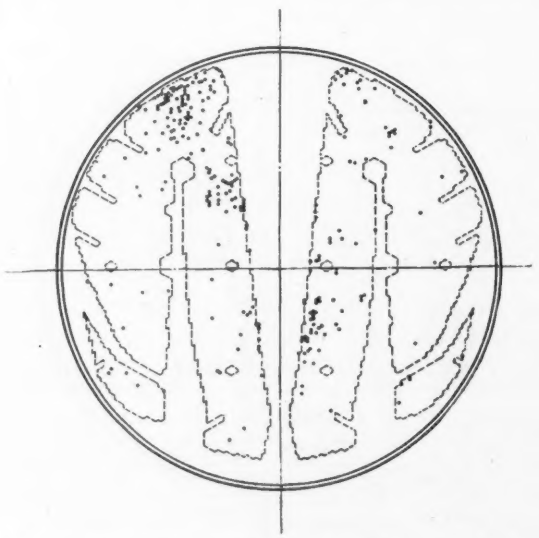


Fig. 3. Tubes Removed from Single-Pass Condenser During Four Years of Operation

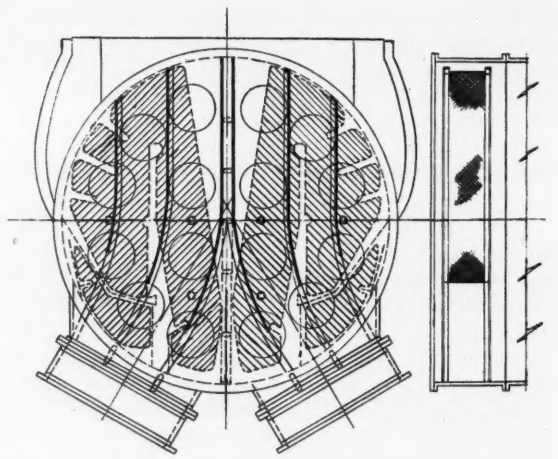


Fig. 4. Guide Vanes Installed in the Inlet Water Box of the Single-Pass Condenser at the Edgar Station

Solving Equations [2] and [3] for u_1 gives

$$u_1 = \sqrt{\left[\frac{\left(h_1 - h_2 - \frac{v_2^2}{2g}\right)2g}{\left(\frac{r_1}{r_2}\right)^2 - 1}\right]} \quad \ldots\ldots\ldots [4]$$

For the hydraulic conditions existent in the condenser, u_1 at a radius of 1 ft. would have to be of the order of 0.5 to 1.0 f.p.s. to produce cavitation, i.e., yield h_2 equal to the vapor pressure. Such tangential velocities have been observed repeatedly. Cavitation, therefore, exists and appears in the divergent part of the bushings, but the collapse occurs downstream therefrom in the bushings and tubes. The relatively low pressure level and the resultant release of air have a damping effect on the action and prevent the pressure from reaching as high a value in the moment of collapse of the vapor cavities as would otherwise be possible. The cavitation effect, however, will be sufficiently strong to destroy possible protective films. The liberated air, then, will accelerate the oxidation, especially when compressed in the moment of cavity collapse.

The Prevention of Cavitation

From the foregoing theoretical analysis, the next step was to prevent the formation of the vortices with their damaging tangential-velocity components in the condenser itself and the resulting cavitation and tube failures. The rotation of the water to form these vortices was effectively stopped by running two circulating pumps at reduced speed and guiding the flow from the two entrances by vanes located as shown in Fig. 4. The vanes were made from brass angles and ¼-in. mesh, 16-Bwg Admiralty metal screen. These guide vanes have effectively eliminated the vortices without increasing the pressure drop across the condenser. The authors are confident that time will prove the effectiveness of the guide vanes in reducing tube losses.

Readers' Conference

The Psychology of Advancement

CONSIDERING the fact that for $50 per week it is possible to hire the best power plant operating engineer in the world, if we are to get very far in life we must do something more than learn all about CO_2 and B.t.u. and chlorine radicals, and so on, as F. S. Hafford has observed in June Power Plant Engineering.

It is taken as axiomatic that ability is essential to success. I suppose that most people believe so, I know that I did once but not so much now. Either I am getting less able to discern truth as I add years to life or that ability and success go together is not the whole of the truth. Those who believe so must explain a lot of contradictions.

That a stupid person can get nowhere, we all agree on that point. Going to the other extreme, that of the brilliant man or woman, on the same reasoning, they should be all successes. But we do not find that to be the case. No matter what century of history we examine we find persons of brilliant minds that were not able to earn a comfortable living.

Barring the feeble minded on one side and those of the brilliant mind on the other, those of average intelligence probably make 99 per cent of the whole. I do not mean to say that these 99 per cent are of equal intelligence but there is no convincing proof that there is a uniform relation between ability and intelligence. If there is some relation there are so many exceptions that, even assuming one has intelligence, that is no assurance that he will get along well in the world.

Mr. Hafford speaks of competent engineers holding subordinate positions under men of less ability. Others have also noted that fact which is in agreement with my contention that ability is no assurance for success and success does not stamp one as a man of ability. There are many chief engineers of power plants that are very capable men but I have also seen men of mediocre caliber holding as good and better positions.

There are those who say that honesty is necessary to success. But we find people of unquestionable honesty mopping floors and some very base fellows reposing in swivel chairs. Others believe that hard work is the road to success, but many hard working people fall exhausted by the wayside of the road to success while some lazy individuals walk to success over their exhausted bodies in ease. The same thing is true of education. There are college men working at $55 per month for the W.P.A., while moving picture operators in Chicago, some of whom cannot sign their name and others who cannot speak English, get from $100 to $200 per week (not month). And the same thing is true of all other qualities which are supposed to be essential to success, but notwithstanding people entirely lacking these qualities succeed, others possessing all of them fail.

Mr. Hafford gives certain directions in approaching a prospective employer, such as being confident, looking in the eye but not staring, etc. But these qualities cannot be assumed at will as we can put on a suit of clothes. To say to a timid person, be confident, is the same as asking a fish to live on land. When Mr. Hafford secured his position as chief engineer he might have displayed a spirit of confidence, looked the interviewer in the eyes in a natural manner and spoke with assurance, but the chances are that he did not will these tactics, but that it was the psychological moment in his life brought about by the concatenation of events beyond our control. But even if being confident and poised can be assumed as an actor does, that will not assure us of getting the position that we want to get. There are many timid persons holding good positions and many brave ones walking the streets. Some of the great men in history were very timid.

That these things are so we have the authority of persons whose time is devoted to the study of this department of life, the study of the mind which is the field of the metaphysician or psychologist. They say that they are so and they have written many books to show why they are so. Most of us think that if we are competent, if we set our goal and work with determination we will succeed. But the psychologist says that we might fail notwithstanding.

If neither ability, nor education, nor honesty, nor hard work, nor determination assure us of getting the better position, what if anything, can we do to improve our condition? Let us see what the psychologist has to say on this subject. We are power engineers, and when people want power they come to us. When we are sick we go to the doctor, when in legal trouble we go to a lawyer. We cannot make advancement in life unless we know the meaning of life and the interpretation of life is the province of the metaphysician. Let us go to the metaphysician.

What the metaphysican has to say on the question of advancement is not acceptable to most of us when we are first confronted with it. It does not seem logical to us because it is contrary to what appears to be the truth. But we find truth quite often opposite to appearance, as for instance, the sun appears to turn about the earth when the opposite is the truth and it took many centuries for men to accept that fact.

Psychologists say that the only sure way for man to advance in life is to become *indifferent to advancement*. He must become "anxious about nothing," or to be able to say with Apostle Paul "none of these things move me," or as Emerson put it "indifferent to circumstance." Of ten men that work for advancement nine will fail and one might succeed but it will not be a true success because it will not add to his joy of living. The progress of the world is due not to those who work for advancement but to those who work for the joy of working and who care nothing about advancement. Of ten men that discover joy in their work, whether it is inventing a machine or passing coal, all ten will advance.

How can we become indifferent to advancement? Why do we want to advance? Why do we want to become chief engineers, vice-presidents, etc.? Because

we believe that these attainments will add to our happiness. But they do not? Nothing is more obvious if we will but look and listen. The realization that higher positions will not add to our joy of living will free us from the greed for attainment, and at the same time attainment will become easier.

Of those who are holding high positions, how did they reach such levels? With the majority of them, although there are a multiplicity of factors, the predominent lament is that of the concatenation of events and not because of any merit on their part. And that is why, though they stand high in the affairs of the world, they do not get any more joy or satisfaction out of life. The president of a concern earning $100,000 per year who does not find more happiness in living than the janitor at $1000 a year is as much a failure as the latter. Then there are those who reach high positions without striving. They do not work for promotion. They simply have discovered the secrets of finding joy in their work and they work for the joy of working with no thought of promotion. But promotion comes to them without conscious effort for advancement, without struggle. Men of the second group are successful indeed.

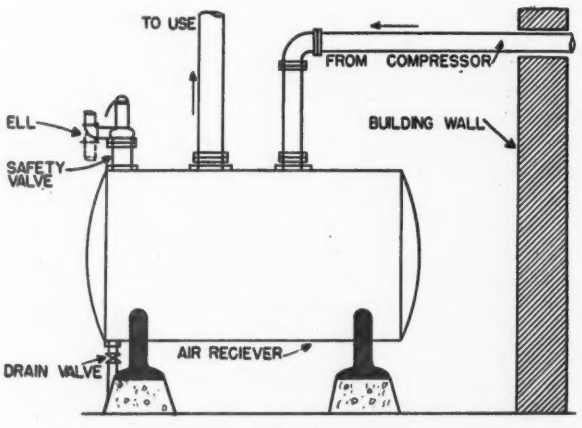
If we are coal passers, and oilers, and firemen how can we find joy in our work? "Seek and ye shall find." A helpful device is to think of your present work as a step and a necessary step to that which you intend to become. Although, after one has once discovered the secret of putting joy in his work he no longer thinks of what he intends to become, he simply tackles each task as it is unfolded before him.

Chicago, Ill. N. T. Pef.

Upturned Ell Causes Safety Valve Failure

When hazards to the safety of plant personnel are eliminated it is sometimes found that the corrective measures make an even worse condition. Such a paradox was recently uncovered in the safety valve piping of an air receiver exposed to the weather on the outside of the compressor room of a large industrial power plant.

As originally installed the discharge opening of the safety valve was fitted with a nipple and an elbow. This elbow was turned downward so that any escaping air would blow towards the ground directly in front of the receiver blowoff valve. An operator bending over to open the blowoff valve in order to drain the accumulated water from the receiver happened one day to receive the full force of the safety valve discharge on the back of his neck. He promptly reported the condition as being dangerous and it was decided that the best method of its alleviation was to turn the elbow upward. All was well until winter when, after much sleet and snow, the temperature dropped suddenly, freezing tight the safety valve opening and seat ring drains. Luckily, however, it was standard operating practice to lift the safety valve by hand at least once daily and the stoppage was discovered before a serious accident occurred. After this experience, all difficulties were eliminated by turning the elbow downward and moving the safety valve 90 deg. so that it discharged over the side of the receiver where it would cause no trouble.



Air Receiver Pipe Connections

New York, N. Y. S. H. Coleman.

Oil Resistant Joints

Oil leakage is a frequent cause of oil loss and also increased fire risk. Oil tight joints are difficult to maintain, as oil is penetrating, particularly when hot. Lead wire joints are satisfactory, but ordinary metal to metal joints are not, but it is important that these are machined smooth and true so that the actual joint can be as thin as possible. For making wide joints ordinary steam jointing material of the asbestos sheet type may be used, but this must be painted with shellac dissolved in methylated spirit just before bolting up. An oil cement which can be used for closing small leaks can be made from two parts glue, one part glycerine and seven parts water. This should be applied warm. A good paste for closing oil leaks and making joints can be made from gum shellac dissolved in a 10 per cent solution of ammonia. This can be applied by brush as a paint after joints are made or to joints found to be leaky. Any oil joints found to leak should be immediately remade, as once joints start to leak they rapidly grow worse.

Sussex, England. W. E. Warner.

A Useful and Handy Testing Outfit

In a modern power plant of any size it is a good investment to have a small, handpowered water pump for testing purposes. This, together with an assortment of flanges and fittings, can be used quite often to advantage. After reconditioning a valve, testing it with hydraulic pressure will insure against failure when it is installed, as a small defect or error in grinding, for instance, may not be readily noticeable to the eye.

Also, pressures and temperatures often cause pinholes, which may be in the castings, to develop into really bad leaks and it is hard to detect these. Even when found, welding may not always remedy the defect at the first try. It is much better to test before reinstalling and save time, trouble and materials.

A case where such a test would have proved advantageous comes to mind. On a high pressure steam line we had, what we thought, was a leaky valve cover joint. The line was sectionalized, rather a troublesome job, and a new gasket was installed. It still blew.

Again we sectionalized, put in another gasket, opened up and—again she blew. We tried several gaskets of various kinds before we really got down to cases and examined the cover. Several of us tried our hands at the job as we thought the "human factor" might be at fault.

On examination we found a tiny pinhole which came out right at the edge of the cover and which, blowing, had fooled us all along into thinking it was the cover gasket. With a test apparatus the cover could have been tested on another body and the defect located sooner.

Incidentally, when pinholes develop, it is usual practice to get the welder but, in these cases, old methods are more satisfactory. Drill through the hole, tap it with a tight thread, screw in a steel stud, cut it off and rivet it over at top and bottom if it is accessible. This old method is 100 per cent satisfactory whereas, even with a really good welder, the welding job is often faulty and the trouble develops again shortly, the steam working its way along between the weld and the casting.

Passaic, N. J. MARK BELL.

Then and Now

BACK IN 1902 I worked in what was termed a large plant, over 20,000 hp. being generated by reciprocating engines.

Twelve large water tube boilers were installed and something like 50 fire tube boilers; over 500 t. of coal were consumed in 24 hr.

The one and only one qualification demanded of a fireman was his ability to transfer one ton of coal per hour from the pile, directly in back of him, into the firebox.

No instruments were in evidence; the water-tender watched the steam and the water. Any fireman that could not make steam enough so that his feed valve was not sufficiently open—to satisfy the water-tender—could not handle one ton per hour and therefore was no longer required.

The plant consisted of 14 engine rooms. Most of the units were compound condensing except a few simple engines whose exhaust was all utilized in heating the feedwater.

But every boiler in the plant was kept clean—on the water side of the tube and on the fire side. As much—or more—hard work was done over the week-end, in cleaning, as was done by the stoker gang during the week.

During my spare time I had been reading about flue gas analysis and I asked the chief if he thought it really meant anything—having in mind that no analysis was ever made at our plant.

"We're doing over 20,000 engine hp." he said, "And we're burning 500 t. of coal in 24 hr. We've got a little test plant that you fellows know nothing about. The big plant compares very favorably with any of our plants in the whole country so we don't worry about this CO_2 stuff, but—you won't stay here forever. Keep studying and when you get in a little plant of your own—try it out."

The following year I was in a little plant of my own and I hired a genuine Orsat. It was all glass and I couldn't sleep until I had built a wooden safe to house it when I was away from the plant.

And I got exactly 6 per cent CO_2. Then I recharged the caustic bottle and tried again with absolutely the same results.

There were two 6-ft. h.r.t. boilers and I had spent much time in cleaning both sides of the tubes. The boilers were clean.

Then, quite accidently, I discovered that the back arch on each boiler (where the gas sweeps from the combustion chamber into the tubes), was away from the rear head all of 2½ or 3 in.

By plugging with dry asbestos pipe covering followed by a plastic made of the same material, I was surprised and decidedly pleased to get samples as high as 14 per cent CO_2.

By looking through my formulæ, I figured the saving of 14 per cent over 6 per cent as follows:

Perfect combustion 20.7 per cent CO_2. Possible 15.0 per cent with a loss of 12 per cent fuel and 38 per cent excess air.

$$20.7 - 14.0 \text{ equals } 6.7; \quad \frac{6.7}{14.0} \text{ equals approx. 48 per cent excess air.}$$

$$\frac{148}{138} \times 12 \text{ equals actual fuel loss or 12.87 per cent.}$$

By the same method, 6 per cent CO_2 loss is 30.0 per cent.

The difference between 30 per cent and 12.87 per cent is 17.13 per cent and the saving was actually one sixth of the coal pile. No change was made in the method of firing; a space of approximately 150 sq. in. (over one sq. ft.) which was allowing over 200 per cent excess air (above the recognized good practice of 38 to 40 per cent), was closed in each setting. That little maneuver saved, in round numbers, $1800 per year and excellent coal was cheap.

Now, let us jump the 35 yr. and take a look at progress, in the small engineering world of today.

It would seem that the average engineer, with several good magazines to choose from, must know the value of combustion and clean boilers.

It would likewise seem that competition in business would cause the average small mill owner to check his power plant to satisfy himself as to its efficiency.

Now a case comes to light that causes the intelligent engineer to gasp and say, "It can't happen to us!" But, if he does not watch his step, it can and will happen to him.

The plant in question had originally one 6-ft. h.r.t. boiler and a small four valve engine. As time passed, the boiler load apparently increased to the point where a new unit was needed to help the old unit.

A very obliging manager signed the engineer's requisition and the new unit was purchased. Now comes along a travelling gentleman whose business demands the use of an Orsat. He makes several tests, with draft gage, pyrometer and CO_2 analyser.

The same condition prevailed as I have stated, in my own experience with the rear arches, only in much further advanced stage. The best CO_2 was less than 5 per cent.

An investigation, over the week-end, revealed that the 90 odd 3½-in. tubes were so badly plugged that a 1-in. steam pipe would hardly pass through. The flue gas temperature, by the way, was over 700 deg. F.

With the boiler properly cleaned, the air leaks stopped and a proper method of firing introduced, a saving of fully 33.3 per cent is obtained. The CO_2 is 14 per cent and the flue gas temperature 450 deg. F.

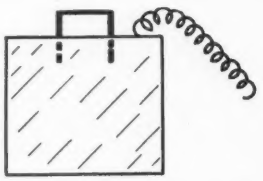
In my own case, upward of 35 yr. ago, a saving of $1800 on two boilers was some achievement; the annual saving, in this case on one boiler of the same type and power will total $8000.

May I again suggest that it can happen to us if we don't watch our step every minute of the twenty-four hours!

New York, N. Y. C. W. PETERS.

Utilizing Worn Out Brushes

PERHAPS SOME other readers of this magazine may be interested in knowing how I utilized worn out generator brushes in an emergency. First, I drilled two small holes in the edge of the brushes on each side of the brush on each side of the spring lever contact



point. Then, I fashioned some flat top staples of copper wire of the right size for a snug fit in the holes, as shown in the sketch herewith. This lengthened the effective portion of the brush, enabling it to be used longer.

Franklin, N. H. C. C. LAWLESS.

Can Engineers Sell Their Services for Their True Value?

EVERYBODY DESIRES to better himself. The engineer is not found lacking in this universal desire for higher living standards which are made possible by increased earnings. A bit of sugar on the bread and butter does not go amiss in these days of sharp increases in living costs. Engineers, moreover, more than any other single group, have been directly responsible for the great improvements that have been made in the comforts of living being enjoyed in every home in the land. These standards they deserve to share.

Seeing them as they plod through their Mollier diagrams, their structural steel tables; or to watch them frown, in deep study, over their log-log slide rules and heat engine problems, one wonders rather seriously about their future. Watching them at work, a casual observer might seriously question their much discussed desire for advancement.

The illusive thing called self-betterment is the goal which makes the problems of today more fascinating, those of tomorrow more challenging. And in solving these problems of steel, of heat, and of the laws of dynamics engineers become more technically proficient, but increasingly less able to deal with the human problems, which more closely affect their own personal welfare. Technical advancement opens new vistas in the realm of hyperbolic formulæ and higher mathematics, but reduces, in direct proportion, the engineer's opportunities for advancement to responsibilities as an executive in business.

What is the solution? Volumes have been written because this ambition to receive proper recognition is as strong in the engineer's make-up as are the obstacles that stand in his way. In his leisure hours he dreams, like other people, of his ship coming into port, laden with the fruits of his endeavor, blown in on the winds of initiative, ambition, and hard work.

We are told that an engineer, in order to accomplish these things, must, above all, be a good salesman—that he must apply the laws of psychology.

When asking for a new position, or seeking more responsibility in the old, he must use subtle flattery on his executives. He must, say his advisers, summon all his self-confidence, yet remember not to boast. He must "know his customer" (in the salesman's terms) and know how he thinks. In short, he must know and use all of the selling tools fashioned from experience by his well-trained associates in the sales department. He must, in reality, compete with them in selling the value of his services to his executives, in order to receive his just rewards.

But just how is an engineer to know how to do all this? In his tedious years of preparing for his job as a technician, what has he learned about this selling business? The chances are ten to one or better that he's never had to sell a thing in his whole life! If selling were made one of the requirements for obtaining his degree of engineer, he would much prefer to ship to the Orient on the first freighter, or to spend his days making wooden door-knobs for South Sea Islanders!

Engineers must face this problem frankly, earnestly, and for all time. They must take the question in hand, determine its solution; then go to work at it heart and soul, enthusiastically, sincerely, and with a firm conviction to really do something about it.

While preparing for their engineering jobs, they must actually practice this thing called Selling. In college vacations they must go out, not into industrial plants to check the r.p.m. of jack-shafts, but into households, offices, stores, hotels, apartments—as house-to-house salesmen. From this actual experience with hundreds and hundreds of different kinds of human beings, they will learn how people think—learn to detect a customer's unexpressed opposition, and to overcome it tactfully, and successfully, without seeming to do so. They must experience that satisfaction, and accompanying self-confidence, that comes from winning many difficult sales (and avoiding all arguments). They must actually sell something—anything—from household brushes to axle grease!

No course in salesmanship, no volumes of advice on how to influence executives, no amount of discourse with successful salesmen, can possibly give the engineer the fundamental self-development that practical selling will supply. He must learn this peddling game as he does his steam engines—from the ground up, and in the actual field of hard-boiled back-to-earth selling.

In so doing, he will learn not only how to influence his executives (which in itself is no small reward for the effort expended!), but also how to guide the reasoning of all with whom he associates. He will, by this experience, help himself to become a leader in his group. His personal profit from this practical knowledge, gained in actual selling work, will therefore be two-fold. He learns the fundamental art of selling, which later proves of inestimable value in enabling him to sell his services for their true value. This is at least as important as his long, painstaking preparation for engineering work. Secondly, in learning the art of influencing his associates, he increases, materially, his value to the company which employs him.

The returns, therefore, from this fundamental knowledge of human nature, obtained by actual work in influencing people to buy something, will vary directly as the square of the effort put into it. The benefits are cumulative.

Putting it into a formula, for all to read, this solution to the problem of engineers' advancement looks something like this:

Future Advancement Varies as the Square of Selling Experience.

Waterbury, Conn. L. M. Duryee.

Maintenance of Speed Ratios

Where it is necessary or desirable to maintain exact speed ratios at all times, it has long been accepted as proper practice to use either gearing or else some form of chain drive, since there is absolutely no possibility of variation in the speed ratio between driver and driven elements. The same thing still holds true, and will probably always be true. It is well worth noting, however, that modern V-belt drives, which have a wedging action in the vees of the pulleys, do so little slipping that they approach maintenance of speed ratios very closely, and for the major share of particular cases are sufficiently accurate.

This greater gripping power of the V-belt has given it preference in many places where it is desirable to keep the speed ratio between driver and drive fairly close, and yet where a small departure from the ideal will do no particular harm. After all, there are few places where the utmost exactitude in this respect is demanded. Where it is, as on the occasional timing job, of course, either gears or chain must be considered the proper selection.

Peoria, Ill. John E. Hyler.

Cleaning Belting

Leather belting which has become dirty and oil soaked may be cleaned by washing with a mixture of petrol and turpentine. After washing with this the belt should be dried with a cloth and then covered with powdered chalk, fine sawdust or Fullers earth. Any of these will absorb any moisture left in the belt, and leave it oil free. Rubber or balata belts, if oil soaked, should be washed in soft soap and water and then dried with a cloth. They should then be covered with any of the three absorbents mentioned before, which will dry out any remaining moisture.

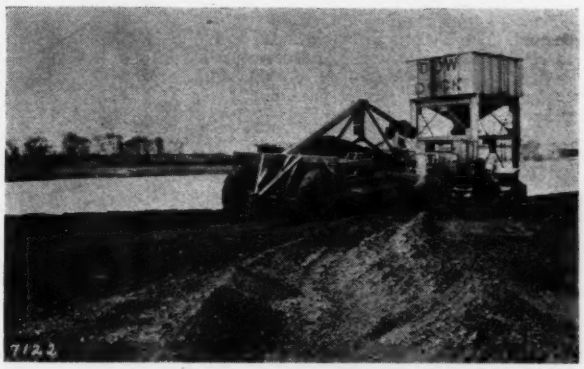
The belts may then be replaced on their pulleys, but before they are put on load a belt dressing should be used on them. The kind of dressing used depends largely on the type of belt, for leather belts many dressings are available, for rubber belts vegetable castor oil or boiled linseed oil should be used, for balata belts use vegetable castor oil. These should be applied only in such quantities as the body of the belt will absorb, without the face becoming sticky. Using a sticky dressing or too much dressing should be avoided, for these make the face of the belt sticky and more pliable to pick up atmospheric impurities which become ground in the belt. Belts should be prevented from becoming dry by a suitable dressing, dry belts more quickly lap up oil and moisture than those kept properly dressed, and are more liable to become oil soaked. The attack of oil and moisture cannot in all places be prevented, such as when oil is splashed from adjacent bearings or the atmosphere is saturated with steam.

Sussex, England. W. E. Warner.

Storing Slack Coal

At Bay City, Mich., Dow Chemical Co. has found a solution to its problem of placing and compacting slack coal in the storage area.

The coal is unloaded from barges by means of an unloading conveyor which deposits the coal along the edge of its track. The coal is then picked up by a Le Tourneau Carryall, which is pulled by a Caterpillar tractor and hauled to the storage area, where the normal travel of tractor and Carryall provides sufficient compacting to prevent internal combustion and reduction in B.t.u. rating. A trailbuilder mounted on the same tractor helps to spread the material.



Tractor and Carryall Used to Store and Pack Coal

The Carryall loads in one-half minute in a distance of 50 ft., and when timed on an 800-ft. round trip, completed the cycle in 5 min. The route included 50 ft. of 5 per cent adverse grade and 75 ft. of 5 per cent favorable grade.

Peoria, Ill. Donald M. Taylor.

Oil Burners for Power Plants—Correction

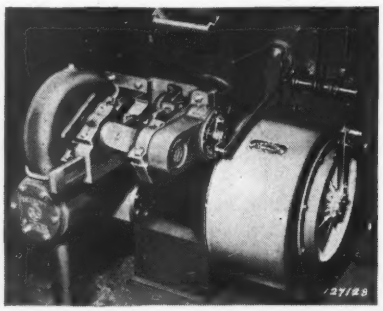
In the article "Oil Burners for Power Plants" on page 438 of the July issue of Power Plant Engineering magazine, there is an error to which the author, Harry W. Benton, calls attention.

In the twelfth line of the second column the word "tank" should be corrected to the word "pipe", so that this twelfth line should read:—around the oil supply pipe to the pump and so installed—.

New Equipment

Detroit Adjustable Feed

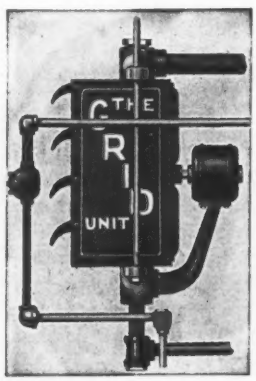
DETROIT single retort and Detroit Uni-Stokers are now equipped with the Detroit adjustable feed built into the right hand crank shaft bracket. This feed may be applied to existing installations when desired. It may be either manually or automatically operated and offers the advantage of an extremely sensitive control of fuel feed to the furnace over a wide range from zero to maximum capacity. If automatically operated, the master regulator which is connected to the Detroit adjustable



feed may also be connected to the damper at the fan inlet or outlet, so that the air supply is synchronized with the fuel feed, as required by changes in load on the boiler, as indicated by steam pressure variations. The master regulator may also be connected to the boiler uptake damper if desired. The Detroit adjustable feed is an extremely simple, compact, fully enclosed device, ruggedly constructed by Detroit Stoker Co., General Motors Building, Detroit, Mich.

Grid Humidifier

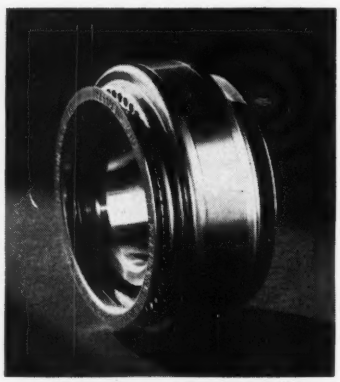
A HUMIDIFIER to be attached either in front of a unit heater or directly behind the unit is announced by The Unit Heater & Cooler Co., Wausau, Wis. Illustrated here, it is known as "Grid" Humidifier. To install it no air lines or extra piping are necessary. The medium for humidifying purposes is immediately at hand in the unit heater. The operation of the humidifier is at temperatures higher than the room atmosphere, which causes quick and instantaneous absorption of the humidifying fluid or gas.



The "Grid" Humidifier may be operated with the unit heater or as an individual unit, and even though the fan on the unit heater is shut down, the humidifying action of the device continues to function until such time as desired conditions are reached in the room, when the controls on the humidifier will shut it down. Installation of the "Grid" Humidifier with unit heaters makes possible their use in all kinds of manufacturing that requires variation in humidity conditions due to special processes or manufacturing conditions.

Oil Film Bearing

DESIGNED to carry the load on an oil film to prevent metal to metal contact, a new bearing known as Fast's Precision Oil Film bearing is being manufactured and marketed by the Fast Bearing Co., Baltimore, Md. Each bearing functions as a self-contained centrifugal oil pump which creates its own lubrication system said to result in virtually unlimited bearing life under the most severe service conditions.



This design, the result of many years' research, development and test, is interchangeable with existing types of ball and roller bearings of the same series made to standard dimensions. It is made in two types, the cylindrical for radial loads, and the spherical or self-aligning for a combination of thrust and radial loads. Both types are made in a range of sizes up to about 5.9 in. bore and for bearing loads of up to 21,000 lb.

Alligator "V" Belt Fasteners

FOR JOINING "C" section "V" belts of fabric core, cross weave construction, a new fastener has been developed by the Flexible Steel Lacing Co. of Chicago. The

fastener makes practicable the installation, shortening or replacement of "V" belts on the job without delays or the necessity of tearing down expensive installations.

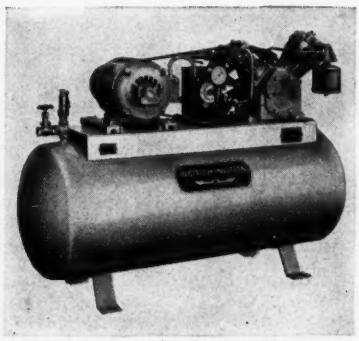
Unique features of the Alligator "V" belt fastener are the double rocker pin supported in bronze bushings and the method of holding the end plate to the belt end without materially weakening the belt or bulging its sides. The rocker pin is made of special alloy steel hardened to give long lasting service. No metal touches the pulleys.

Compressor Units

ANNOUNCEMENT is made of an improved line of tank-mounted compressor units for general industrial service developed by Worthington Pump and Machinery Corp., Harrison, New Jersey.

Single-stage units are available with vertical compressors. The motor sizes range from ¼ to 5 hp., with displacements from 1.43 to 67 cu. ft. per min. at a maximum pressure of 250 lb. per sq. in.

Two-stage units are available with angle-type compressors. The motor sizes

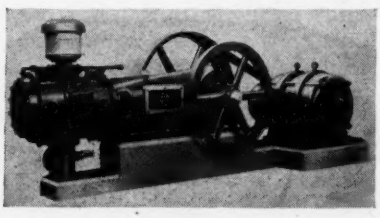


range from ¾ to 10 hp., with displacements from 3.9 to 45 cu. ft. per min. at a maximum pressure of 250 lb. per sq. in.

A pressure switch, with a valve for unloading the compressor when starting or stopping, is furnished on all models. All units are equipped with Worthington feather valves. The crankshaft is carefully balanced to insure smooth operation. Full-floating wrist pins provide durability and quietness. The honed cylinder walls reduce friction and increase the life of the piston rings. Most models are available with either vertical or horizontal air receivers.

Gardner-Denver Improved Compressor

AN IMPROVED single stage, horizontal air compressor for heavy-duty full load service and continuous operation at low power costs has recently been put on the market by The Gardner-Denver Co., Quincy, Ill. Known as the "RX" Compressor, it has totally enclosed dustproof

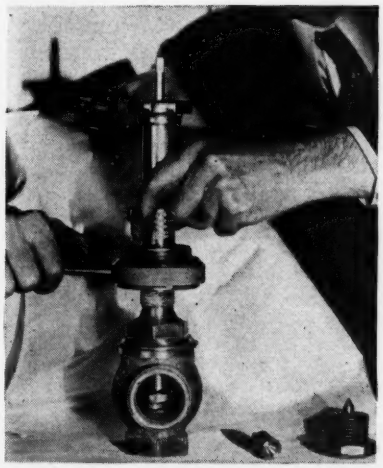


construction without sacrifice of accessibility as well as accurate balance and freedom from vibration.

Another important feature of the "RX" compressors is the electro-pneumatic control. With this control the compressor always starts unloaded and the air supply is automatically adjusted to fit the air requirements, resulting in exceptional part-load economy. The compressors are equipped with Timken tapered adjustable roller main bearings.

Standard Reseater

AMONG the newer tools used by power plant engineers is the Standard Reseater manufactured by the Standard Reseater Corp., 423 West 126th St., New York, N. Y. These tools are made up in sets, the Standard set comprises a chuck including male grip-jaw, four combination reamer-taps, combination ball cock guide, spiral reamer for ground-in joint, tool holder shaft, screw feed guide and feed handle, wheel handle, adjusting ring handle, hexagonal seat and tool wrenches, pin light, five step adapter for female thread, female thread grip-jaws, ratchet tool holder handle, rack for special tools, and steel tool box.



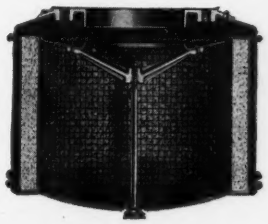
With these tools, globe or angle valves may be reseated without removing them from the pipe line either by reaming the seats or by tapping the seats and inserting removable seats. Standard reseaters are applicable to many other types of valves such as faucets, flush-tank ball cocks, concealed fittings, vacuum traps and many special valves. The adjusting devices assure accurate alinement and precision results.

Diesel Engine

MEDIUM SPEED heavy duty Diesel engines in from 3 to 8 cylinders, rated at from 90 to 300 hp. and convertible to gas are announced by the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City The new design, known as Type 8, is of the four cycle, direct injection type, with all wearing parts completely enclosed. Cylinder dimensions are 8 in. bore by 10½ in. stroke. Four models in 3, 4, 6 and 8 cylinders are offered in horsepower range of 90 to 300 at 600 to 720 r.p.m.

Air Cleaner

TO REMOVE dust and grit from the intake of large gas or Diesel engines, compressors and pumps, the Acoustic Div. of the Burgess Battery Co., 111 West Monroe St., Chicago, Ill., has developed the I-F Series Air Cleaner. This unit, which is



available in capacities up to 3150 c.f.m. at maximum velocities of 4000 f.p.m., can be used alone, or, if silencing is required, in conjunction with the Burgess CA Series Intake Silencer. The new cleaner is of the viscous-coated impingement type and has a filter consisting of a specially wound copper gimp coated with a viscous fluid.

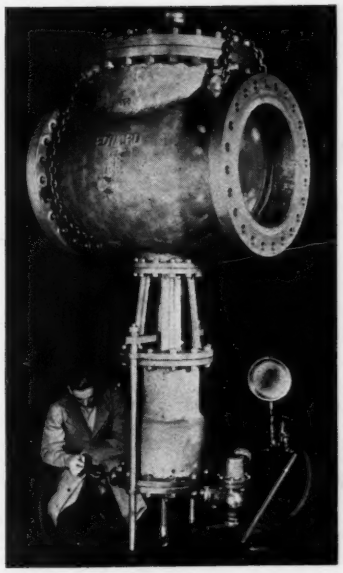
Improved Bonding Mortar

HARWACO BOND, a high temperature bonding mortar, manufactured by Harbison-Walker Refractories Co., Pittsburgh, Pa., and recommended for use in industrial furnace masonry has recently been improved in refractoriness and working quality.

The improved product has a pyrometric cone equivalent of Cone 32 (3092 deg. F.). Use of this diaspore-base bonding mortar in place of mortar consisting essentially of fire clay is becoming increasingly general for laying fireclay, super-duty fireclay, and high-alumina brick where a strong bond must be maintained at the upper limits of industrial furnace operating temperatures. It remains uniformly soft and plastic throughout the steel drum or container in which it is shipped.

1200-lb. Check Valve

LATEST CONSTRUCTION in top plant valves is well typified by a 24-in. 200-lb. swing check valve recently built by The Edward Valve & Mfg. Co., Inc., East Chicago, Ind., and installed in a line from a 1200-lb. steam turbine to protect the unit against entry of steam from the 200-lb. station header. It acts normally as a check valve but is so designed that it will close automatically when the turbine overspeeds. Overspeeding causes a drop in oil pressure on top of the piston of a 2-in. pilot valve. A spring under this piston then pushes it into position to drain the oil from under the piston of the main cylinder. A heavy spring acting through rods then pulls the main valve disk against its seat. The nearly

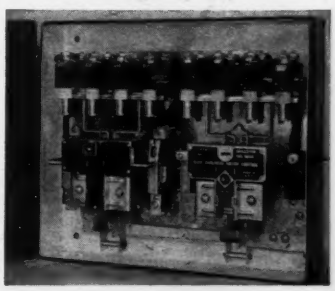


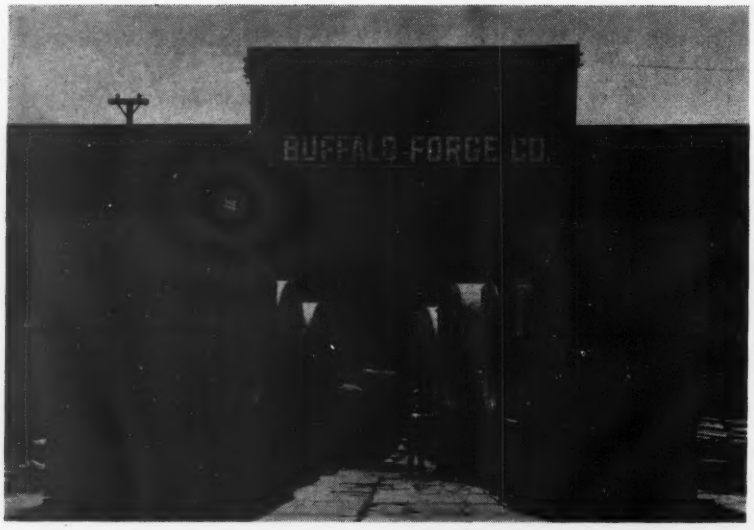
compressed spring exerts almost five tons of pressure against the piston, assuring positive closing in case of loss of oil pressure.

The valve is unusually compact, as it was designed to fit into a given space and has a welded-in seat with Stellited seating face coinciding with the Stellited face of disk; stainless steel guiding rods; and lantern type stuffing box. As a safety feature the location and design of the oil cylinder is such as to prevent any possible contact between hot steam and oil. The net weight of the valve is 5700 lb.

Reversing Motor Starter

ALLIS-CHALMERS MFG. CO. Conduit Works, Boston, Mass., announces a new reversing motor starter, designated type AP-7-R, furnished for 7½ hp., 550 v., or less. The starter consists of two type AP-7 motor starter units, mechanically interlocked so that either unit cannot be closed if the other is closed. The starter units are equipped with Ruptors. The Ruptors consist of enclosing chambers which confine and depotentiate the arc formed by circuit interruption. They increase the interrupting ability of the contacts and form individual isolating barriers between contacts of opposite polarity. Other features are as follows: Large silver double break contacts; solenoid operated, vertical make and break; unit construction; enclosed temperature overload relays affording positive motor protection; undervoltage protection inherently provided.



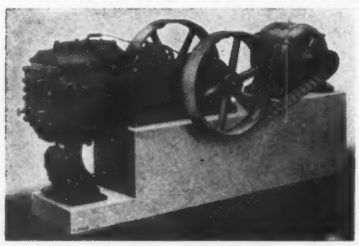


These 6 of 36 Buffalo Limit-Load Ventilating Fans, ready for shipment from the Buffalo Forge Co. plant, will supply and exhaust air from the New Lincoln Vehicular Tunnel under the Hudson River at 39th St., New York City. Each fan weighs approximately 10 t. The 17 supply fans handle a total of 3,218,000 cu. ft. of air per minute. At a density of 0.08 lb. per cu. ft. this equals 370,000,000 lb. per day or 185,000 t. per day. Enough air for 10,600,000 people for one day at 35 lb. per person. The nineteen exhaust fans handle a total of 3,088,400 cu. ft. of air per minute. At a density of 0.0784 lb. per cu. ft., this equals 350,000,000 lb. per day or 175,000 t. per day. Enough to take the breath away from 10,000,000 people.

Dry Vacuum Pumps

FOR HANDLING AIR and vapors not liquified in the condenser or for pulling a vacuum in any closed system in the chemical and process industries Worthington Pump & Mach. Corp., Harrison, N. J., offers an improved line of single-stage and two-stage horizontal dry vacuum pumps for which high volumetric efficiencies are claimed.

Minimum clearances, necessary because of the direct relation to volumetric efficiency, are maintained by the design of the close-grained, semi-steel vacuum cylinders. Other features include large cylinder passages and large valve areas which reduce losses, and head and cylinder water jackets provided with hand holes for easy cleaning. The double-row tapered-roller-type main bearings are mounted in assemblies, rigidly bolted to the side of the main



frame and held in alinement by centering rings. Provision has been made for adjustment. Additional details include lightweight cast-iron pistons, a frame of massive construction, and two counterbalances fitted on an open-hearth steel crankshaft. The entire pump is completely and automatically lubricated. A gage glass provides visible indication of the depth of oil in the crankcase.

These single-stage and two-stage units are both built in eight sizes. The former have piston displacements of 250 to 2832 and the latter of 138 to 1425 c.f.m. Single stage units are employed for a vacuum of 28 in. or less and two-stage units when a higher vacuum is desired.

ELECTRIC HOSE & RUBBER CO., Wilmington, Del., has just issued a pocket-size, loose-leaf, 64-page catalog of its line of braided and molded hose, available to anybody who writes for it on a business letter head.

Thermometers

DIAL THERMOMETERS which may be set at any angle have been introduced by the American Schaeffer & Budenberg Div. of Consolidated Ashcroft Hancock Co., Bridgeport, Conn. The bulb fits any existing glass thermometer socket and the dial

may be adjusted at any angle in relation to the stem. They are available in two sizes, 4½ and 6 in., in 9 standard ranges from —40 to 1000 deg. F. The bulb is made with a standard union bushing connection, with a separable socket or with an adapter neck union bushing connection.

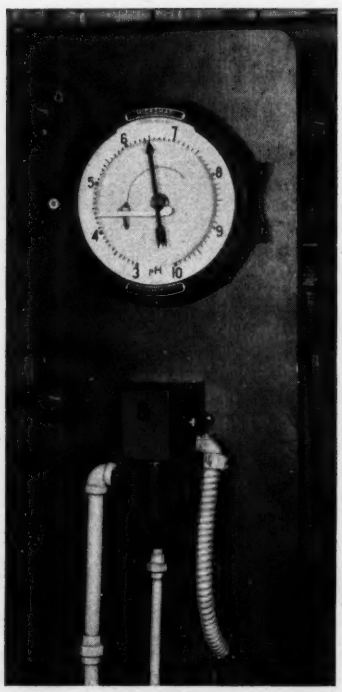
JEFFREY MFG. CO., Columbus, Ohio, has a new single-roll crusher for preparation of stoker and smaller size coal with minimum of under and over sizes. Renewable segments carry thin, sharp-pyramid and spearpoint teeth, with insertable feeder teeth for reduction of large coal. These are designed to cause a piercing rather than mashing action while a new design of breaker plate eliminates boiling of the feed and an extended shoe helps to increase the field of action of the roll and reduce oversizes.

pH Recorder

TO MAKE IT POSSIBLE for operators to regulate water treatment reagents by the pH value, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., has introduced a pH indicator recorder and controller. An antimony-calomel electrode assembly automatically detects the pH of a continuously flowing sample of boiler feedwater or makeup and a standard Micromax, located wherever convenient, automatically indicates and records pH values and if desired, automatically controls the reagent-input.

Operators regulating the addition of acid, soda ash, phosphates or other reagent to feedwater or makeup may now be guided by a bold dial on which a big black pointer continuously indicates pH. For automatic operation an operator simply turns a control setter to the prescribed pH value and thereafter the reagent input is automatically adjusted in response to pH deviation from the control value.

This equipment is advantageous to boiler-plants, oil refineries, water purification plants, and by many manufacturers of food products, beverages, ice, chemicals, textiles and textile products.



Stoker Manufacturers Elect Officers

THE ANNUAL MEETING of the Stoker Manufacturers' Association took place at the Greenbrier Inn, White Sulphur Springs, West Virginia, on June 3 and 4, with a well rounded program dealing with research, engineering, advertising, trade practices and legislation. These topics were discussed at great length by the executives of member companies attending the two-day meeting, with the first day's meeting being devoted to executive consideration of these and other industry problems.

The sessions on June 4 were in the nature of open meetings at which time representatives of railroads, coal operators, trade associations, heating engineers and the press were present. Short addresses on subjects of mutual interest to the stoker and allied industries were presented by the following: George G. Ritchie, fuel service engineer, Chesapeake & Ohio Lines, Richmond, Va.; Fred K. Prosser, coal traffic manager, Norfolk & Western Railway, Roanoke, Va.; J. D. Battle, executive secretary, National Coal Association, Washington, D. C.; J. E. Tobey, manager, fuel engineering department, Appalachian Coals, Inc., Cincinnati, Ohio; W. B. Hughes, manager, automatic coal burning division, American Radiator Co., New York City; Ralph A. Sherman, fuel engineer, Battelle Memorial Institute and Bituminous Coal Research, Inc., Columbus, Ohio; Allen J. Johnson, director, Anthracite Industries Laboratory, Primos, Penna.; A. F. H. Scott, assistant to president, Anthracite Industries, New York City; E. K. Scoggin, Minneapolis-Honeywell Regulator Co., Minneapolis; Malcolm E. Henning, vice president, Penn Electric Switch Co., Des Moines, Iowa; Howard M. Davidson, Better Homes & Gardens magazine, Chicago, and Lyman M. Forbes, director market research, American Builder magazine, Chicago.

Ray C. Goddard, vice president, Combustion division, the Steel Products Engineering Co., was re-elected president of the Association; E. C. Sammons, vice President, Iron Fireman Manufacturing Co., Portland, Oregon, was elected vice president; and G. Walter Ostrand, plant manager, Link-Belt Co., Chicago, was chosen treasurer. Marc G. Bluth, Chicago, was re-appointed as secretary of the Association.

F. E. Barth Heads Graton & Knight Co.

FREDERICK E. BARTH, for 11 yr. vice-president of Graton & Knight Co., was elected president at a meeting of the directors June 16 to succeed the late Frank H. Willard. Mr. Barth has been with the company since 1919, serving first as office manager and then as general sales manager from 1924 until 1926 when he was elected vice-president and assistant general manager.

He was born in New York, April 9, 1894, the son of the late Edward G., and Clara Barth who now lives at Red Hook, N. J. He attended the New York City schools, was graduated from Pace and Pace Business Institute in 1914 and began to work for Baker and Taylor Book Co., in New York as a clerk. Later he joined the L. L. Harr Corp., production and accounting engineers, with whom he went to Worcester in 1917 to work on production problems in the Graton & Knight factory.

Mr. Barth takes the presidency left vacant by the death May 25 of Mr. Willard, who had been president since 1926, and who at the time of his death had served 53 years with Graton & Knight. He is the author of widely distributed articles on phases of cost accounting and leather manufacturing.

Electronic Automatic Alternator Voltage Regulators

WARD LEONARD ELECTRIC CO. of Mount Vernon has developed and marketed two automatic electronic alternator voltage regulators that perform the same functions as do other and older types of quick response regulators.

There are no moving parts in these regulators. Instead of relying upon mechanical means to close contacts or change pressures a stream of electrons controls the regulating action.

The regulators are controlled rectifiers deriving their power from the A.C. generator and delivering the rectified direct current to the shunt field of the exciter in an amount which is a function of the A.C. generator potential.

The corrective action of Type EF Regulators starts within one-half cycle (1/120 second) of the slightest change in generator voltage; and Type EB Regulators start within one cycle (1/60 second).

Type EF Regulator is designed so that it can be used with any known method of excitation. This regulator is now designed with an isolated supply transformer making the larger capacities more easily arranged for switchboard mounting.

Type EB Regulator is designed for use with one exciter only. It has a wide range of application, first in small plants which have only one generating unit and second in providing individual regulators for plants operating two or more generating units in parallel. It is less expensive than the EF type.

Variations of these regulators can be obtained to maintain constant voltage on 180 cycle generators, such as may be used to provide power for high speed portable tools, power factor regulations, etc.

These Electronic Regulators, obtainable at a comparatively low initial cost, are easy to install, require no maintenance, or replacement, except electronic tubes which have long life.

The Inside Story

IN THE BEST Hollywood manner Dr. Diesel is introduced to the public by Socony-Vacuum's new movie "The Inside Story," dramatizing Oil's part in industrial progress. Dr. Diesel shown with his hand on the cylinder head is perhaps considering if he should tempt fate by starting his brain child for the first time. Dr. Diesel disappeared mysteriously just before the war but he barely escaped an untimely death twenty years earlier when his first engine exploded. Successful lubrication of the Modern Diesel is but one of the many triumphs of the lubrication engineer.

News from the Field

GEORGE F. WILLSON, Cleveland, Ohio, sales representative of the Acheson Colloids Corp., has been granted a patent on a composition, of which colloidal graphite is an important constituent, designed for rubber lubrication. This patent has been assigned to the Acheson Colloids Corp., Port Huron, Mich.

JOSEPH O'CONNOR, formerly president of Kieley & Mueller, Inc., of New York and Newark, has again been made president of this company after an absence of 2 yr. during which time he was head of a large textile concern. Prior to 1935 Mr. O'Connor was president of the Kieley & Mueller organization for over 12 yr. News.

FRED E. GORE, vice president, Blue Diamond Coal Sales Co., and Robert W. Lea, president, West Virginia Coal & Coke Corp., were recently elected members of the board of directors, Appalachian Coals, Inc., Mr. Gore succeeding the late James M. Bonnyman, and Mr. Lea replacing John C. Cosgrove, resigned. At the meeting, R. E. Howe, vice president, advised the board that the National Bituminous Coal Commission had granted temporary approval of the ACI marketing agency, and the directors instructed Mr. Howe to make application on behalf of Appalachian Coals, Inc., for "provisional approval of its continued operation" under Order No. 6 of the Commission.

LEON M. FUQUAY has been appointed secretary of Federal Power Commission. He is a graduate of University of North Carolina and the Law School of George Washington University, was principal and instructor in government and modern languages at Koehler, N. M., for 2 yr., and acted as aide to the ranking democratic member of the U. S. Senate finance committee for 6 yr. Since 1931 he has served as secretary to the commissioner, later to the chairman, and since 1934 assistant secretary to the commission, being acting secretary for the last 1½ yr.

SIMEON JESTER, JR., formerly with the sales department of the Philadelphia office of American Engineering Co., was transferred to the Chicago office of that company on July 15th. He will supervise the western Hele-Shaw Pump and Lo-Hed Hoist agents, and be responsible for direct sales of marine deck auxiliary equipment. Mr. Jester is a graduate of Massachusetts Institute of Technology, and has been connected with the American Engineering Co. for the past 2 yr.

TRUAX-TRAER COAL CO., whose Cabin Creek division is a producer of Appalachian Coals, Inc., has leased 8000 acres in Raleigh Co., Va., known as Chesapeake & Ohio acreage, from Western Pocahontas Fuel Co. It is estimated to contain 20 million tons of high quality domestic coal. Another tract, Marsh Fork Coal Co. lands has been leased from Rowland Land Co. It is announced that new tipple facilities are being constructed and the properties will be in production by early fall.

ISLAND CREEK COAL CO., one of the producing companies of Appalachian Coals, Inc., is installing automatic aerial tramway systems for disposal of mine waste at its three mines in Holden, W. Va., all installations being similar, with the main units interchangeable.

Refuse will be dumped in hollows, 1300 to 2500 ft. from the tipples, at average rate of 60 to 100 ton an hour, with provision for 20 to 70 yr. storage. Installations, designed and installed by the Interstate Equipment Corp., New York City, provide automatic feeding from the present refuse bins to the tramway cars by reciprocating plate feeders and charging skip-hoists.

PLANS ARE going forward for the Golden Gate International Exposition in San Francisco in 1939. Contract has recently been signed for exhibit of General Electric Co.'s House of Magic in the Palace of Electricity and Communications. The latter will be 200 by 447 ft., near the entrance. General Electric Co.'s interests at the exposition are in charge of A. V. Thompson.

IDEAL COMMUTATOR DRESSER CO., of Sycamore, Ill., has bought out the revolution counter business of the Belden Manufacturing Co. Hereafter, this product will be marketed and manufactured at Sycamore.

ADVISORY COMMITTEE of the Chicago Exposition of Power and Mechanical Engineering, to be held at the New International Amphitheatre, at Chicago, October 4 to 9, 1937, has just been announced. Members of the Committee are as follows: Chairman, J. Edwin Koch, Heating Plant Supervisor, Chicago Union Station Co.; J. S. Banta, District Engineer, American Steel & Wire Co.; Edward A. Bull, President, Producers Terminal Corp.; Joseph F. Darlington, Consulting Engineer, Winston & Co.; F. T. Darrow, Chief Engineer, Chicago, Burlington & Quincy Railroad Co.; Chester T. Dike, Vice President & Chief Engineer, Chicago & North Western Railway Co.; George G. Ensign, Chief Engineer, Elgin National Watch Co.; A. Fabel, Chief Engineer, Marshall Field & Co.; S. R. Jensen, Chief Engineer, The University of Chicago; F. H. Lane, Manager Engineering Construction, Public Utilities Engineering & Service Corp.; Fred W. Lewis, Chief Engineer, Wilson & Co., Inc., R. M. Morrison, Chief Engineer, The Chicago Tribune; W. H. Penfield, Chief Engineer, Chicago, Milwaukee, St. Paul & Pacific Railroad Co.; J. B. Pohndorf, Chief Engineer, Chicago Daily News Building; Charles F. Roth, Manager of the Exposition.

Mr. Roth, Vice President of the International Exposition Co., will be the manager of the Exposition and all matters of contract and arrangement will be under his personal direction.

OSCAR A. HAAS, formerly connected with Allis-Chalmers Mfg. Co.'s Tulsa District Office, and recently Chief Engineer Okla. Iron Wks. and Int. Supply Co., has been appointed Manager of that District, succeeding D. M. McCargar, who has been advanced to the general position of Engineer, Petroleum Industry for that Company, with mailing address in care of its Tulsa Office.

NEW HAVEN, CONN., Branch District Office of Allis-Chalmers Mfg. Co. is now located in the Powell Building at 157 Church Street. E. D. Hill will continue as Branch Office Manager. B. L. Chapin, Sales Engineer, has been added to the staff there.

ANNOUNCEMENT is made by The Terry Steam Turbine Co. that effective July 1 the following district representatives will handle the sales of Terry turbines, reduction gears, turbo-generator units, and other products: Walter Cooke, 846 Baronne St., New Orleans, La.; Cowles & Co., 509 Mercantile Building, Dallas, Texas; M. N. Dannenbaum Co., 202 Petroleum Building, Houston, Texas; and W. V. C. Jackson, National Bank of Tulsa Bldg., Tulsa, Okla.

MITCHELL MARTIN FREY, JR., resigned his position, effective July 1, as Secretary and Treasurer of the Wm. B. Scaife & Sons Co., Oakmont, Pa. Mr. Frey began his services with this company in 1889 and has been employed continuously for almost 48 yr. since then. He began as an office boy, later on, he was transferred to the shipping department. In 1916, the Board of Directors elected Mr. Frey to fill the position of Secretary and Treasurer of the Co. left vacant by the death of C. C. Scaife, Jr., which position he has held ever since. Mr. Frey will discontinue his active service with the company, but will continue as a member of the Board of Directors of the firm. Archie V. Murray was recently elected to succeed Mr. Frey as Secretary and Treasurer.

A.S.T.M. Officers and Awards

A. E. WHITE, professor of metallurgical engineer and director of the department of engineering research at the University of Michigan, Ann Arbor, Mich., has been elected president of the A.S.T.M. for the ensuing year. Following his graduation from Brown University, 1907, and a year of study at Harvard, 1908, Doctor White was in charge of research on blast-furnace by-products, ores, etc., for Jones & Laughlin Steel Co. In 1911 he became instructor at the University of Michigan, assistant professor 1913-1917. He has held his present positions since 1919. From 1917 to 1919 he served in the Ordnance Department, U. S. A.—was head of the Metallurgical Branch, Inspection Division and also head of the Metallurgical Branch Technical Staff. In 1925 Brown University awarded him the honorary degree of Doctor of Science.

H. H. Morgan, manager of the Rail and Track Fastenings Dept., Robert W. Hunt Co., Chicago, Ill., has been elected vice president and the following have been elected members of the executive committee: P. H. Bates, Chief, Clay and Silicate Products Div., National Bureau of Standards, Washington, D. C.; H. F. Clemmer, Engineer of Materials, District of Columbia, Washington, D. C.; C. E. F. Lundell, Assistant Chief, Chemistry Division, National Bureau of Standards, Washington, D. C.; H. C. Mougey, Chief Chemist and Assistant Technical Director, Research Laboratories Division, General Motors Corp., Detroit, Mich.; R. L. Templin, Chief Engineer of Tests, Aluminum Co. of America, New Kensington, Pa.

W. H. Swanger, Chief, Section of Mechanical Metallurgy, and Assistant Chief, Division of Metallurgy, and G. F. Wohlgemuth, Associate Metallurgist, respectively, National Bureau of Standards, have been chosen as winners of the Charles B. Dudley Medal for 1937. This medal, which commemorates the name of the first A.S.T.M. President (1902-1909), is awarded to the author or authors of the paper presented at the preceding annual meeting which is of outstanding merit and constitutes an original contribution on research in engineering materials. The winning paper entitled "Failure of Heat-

Treated Steel Wire in Cables of the Mt. Hope, R. I., Suspension Bridge" described the extension work undertaken at the National Bureau of Standards to determine the causes of the failure.

HENRY S. DEMAREST, president and treasurer of Greene, Tweed & Co., New York, died on July 11 at the age of 70 years, having been born in Brooklyn in 1867. Mr. Demarest spent a lifetime in the mill supply business and since 1900 has been engaged in the manufacture of such equipment. He was a member of the American Society of Mechanical Engineers and took part in the activities of a number of social organizations and clubs. He has contributed a lasting service to engineering through improvements in mill supplies, particularly mechanical packing.

Hugh L. Cooper Dies

COL. HUGH L. COOPER, pioneer hydroelectric engineer who designed and supervised the construction of Wilson Dam at Muscle Shoals on the Tennessee River and the Dnieprostroy Dam and Power Station in Russia, died at his home in Stamford, Conn., on June 24. He was 72 years old and had been ill three weeks previous to his death.

Mr. Cooper was one of America's outstanding hydraulic power engineers and during the past 45 years designed projects producing more than 2,000,000 hp. and costing $200,000,000 throughout the world. The Dnieprostroy Dam in the Ukraine was the world's largest dam until Boulder Dam was finished. This project was started in 1927 and Col. Cooper was placed in full charge of the work. He stayed in Russia six years and at the completion of the project received the order of the Red Banner, one of the highest decorations bestowed by the Soviet government.

Born in Sheldon, Minn., in 1865, he was one of the pioneers in the hydroelectric engineering field. At that time the production of electric power by hydroelectric plants had just begun and he was among the few far sighted men who saw that rivers could be put directly to work in generating electricity. His first large job was the damming of the Mississippi River at Keokuk, Iowa, a project that marked an entire change in the attitude toward hydroelectric practice. This was the first large low head plant and its success paved the way for the development of similar types of plants all over the world.

Air Conditioning Stressed at A.S.H.&V.E. Meeting

AIR CONDITIONING at costs applicable to homes of moderate size occupied the attention of the American Society of Heating and Ventilating Engineers at its annual summer meeting at Swampscott, Mass., stress being laid on the importance of research to determine how air conditioning can be adapted to the changing complexities of modern living.

The subject of building construction and insulating materials was emphasized as means which would open the door to wider use of air conditioning in all types of buildings. Envisaging the air conditioned home of the future with a flat topped roof covered with water to provide extra insulation in summer and winter and the more extensive use of glass blocks in both residential and industrial buildings, the society's committee on research set on foot several broad investigations aimed at bringing about a closer understanding between the air conditioning industry and the building material manufacturers.

Progress was reported in the development of a standard code for summer air conditioning requirements intended to protect the public against faulty application of air conditioning systems and to serve as a guide in the design of equipment. This work is in charge of a joint committee representing the society and the American Society of Refrigerating Engineers. Continued studies of the physiological effect of air conditioning on the human body, the elimination of drafts, the minimizing of noise and the more efficient cleaning of air involving the use of new electrical precipitation methods came in for particular attention.

About 500 members of the society attended this year's meeting. It was announced that the regular annual meeting of the society would be held in New York during the week of January 24 of next year in connection with the National Heating and Ventilating Exposition. Next year's summer meeting will be held at Hot Springs, Va., June 20-22.

Titles of the papers presented at the Swampscott meeting were: "The Adaptability of Pre-Cooling Coils to Air Washer Systems" by John Everetts, Jr.; "How Much Power Will an Air Conditioning System Use?" by A. D. Marston; "Cooling Load Analysis of a Bank Building" by John James; "Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52 and 46 deg. F." by A. P. Kratz, S. Konzo and E. L. Broderick; "Report of A.S.H.V.E.-A.S.R.E. Committee on National Standards for Air Conditioning Applications," by L. A. Harding, Chairman; "Calculated Over-All Coefficients for Walls with Air Space Insulation" by F. B. Rowley; "Radiation and Convection Across Air Space in Frame Construction" by Gordon B. Wilkes and Carl M. F. Peterson; "Performance of Fin Tube Units for Air Cooling and Dehumidifying" by G. L. Tuve and C. A. McKeeman; "The Cooling and Heating Rates of a Room with Different Types of Steam Radiators and Convectors" by A. P. Kratz, M. K. Fahnstock and E. L. Broderick; "An Alternate Method of Comparing the Dust Arrestance of Air Cleaning Devices" by Arthur Nutting; "Ventilation Requirements, Part II" by C. P. Yaglou and W. N. Witheridge; "Corrosion Studies in Steam Heating System" by R. R. Seeber and Margaret R. Holley; "Heating Requirements of an Office Building as Influenced by the Stack Effect" by F. C. Houghten and Carl Gutberlet.

"Plug-in" Instruments Under Development

BY INGENIOUS design and developing a.c. and d.c. ammeters, voltmeters, and similar electrical instruments so they may be simply plugged into a universal self supporting socket mounted directly in the wiring conduit, Westinghouse engineers hope to reduce ordinary industrial installation costs of instruments by 35 per cent as compared to present day practice. Industries powered by individual drive, such as the machine and textile industries, will particularly benefit since the development makes practical the low cost use of instruments to act as guide for "production speed vs. machine life".

With four years' development behind it, the present universal socket will give any desired load conditions by merely plugging in an ammeter, voltmeter, watthour meter, etc., one after another in the same socket. Standard "troughs" (all metal boxes), with several sockets, will be used when more than one instrument is to be read at the same time, and can be mounted much like a motor starter. Quick and easy mounting has been worked out for ordinary wiring, such as rigid conduit, open wiring or cable.

W. M. Bradshaw, Westinghouse Manager of Meter Engineering, demonstrates the simplicity of the new plug-in instruments which will soon be commercially available, to Sales Manager Spartes (left).

For the Engineer's Library

DIELECTRIC PHENOMENA IN HIGH VOLTAGE CABLES. By D. M. Robinson. 173 pages, 5½ by 8½ in. Illustrated. Published by Instruments Publishing Co., Pittsburgh, Pa., 1936. Price $5.00.

The electric transmission cable, especially the underground cable, is perhaps the least spectacular of all the elements comprising the electric system. A large turbogenerator is a thing impressive to the eye, its dimensions and its obvious display of power as one stands beside it leaves little to the imagination. A large transformer though less forceful still has dimensions which impress one with its importance. Switchgear with its complicated mechanism, its multiplicity of elements also provides direct evidence of its importance in the system. A reel or drum of underground cable, however, lying about in the supply yard or along the public highway is about as prosaic an object as one might find anywhere, certainly it does not impress one as being anything on which a great deal of research could have been expended.

And yet that drum of cable is an achievement in electrical science that compares favorably if not actually surpasses that involved in one of our modern generators. A cable operates at higher voltages than the generators, it cannot have the generous dimensions permitted for the same voltages in generators or transformers nor is it as easy to keep full of oil as in the case of transformers. It must be wound on a drum, stand about on site, be manhandled into awkward trenches or pulled through ducts, and then it is expected to last indefinitely without further care or inspection, maintaining forty to a hundred or more thousand volts between its conductor and sheath and undergo daily or weekly variations of load sufficient to cause 40 or 50 degree changes of temperature.

Taking this view of the cable gives one an entirely different sense of its importance and a new appreciation of the difficulties involved in its successful development. The problems involved in cable design and construction are primarily problems of insulation and dielectrics.

Although much has been written on the subject of insulation, the literature is scattered and available only by extensive research. It is, therefore, gratifying to have a book such as this which gives a comprehensive yet compact treatment of the subject of cable insulation as a whole, a modern orientation of all its complex elements. This book is Volume III of a series of monographs on electrical engineering each of which accomplishes a similar purpose for other subjects. Although the authors are both English much of the material used in the book is of American origin and the viewpoint is sufficiently general to make the book as useful to the American engineer as the English. Much of the material was drawn from the transactions of the engineering societies. Although of general interest to any electrical engineer the book should be of particular interest to the student of cable manufacturing technique. The author is Research Engineer at Callender's Cable and Construction Co., Ltd.

PYRAMIDS OF POWER. By M. L. Ramsay. First edition. 326 pages, illustrated. Cloth, 6 by 8½ in. Bobbs-Merrill Co., Indianapolis, Ind., 1937. Price $2.75.

This is the story of Roosevelt, Insull and the Utility Wars. Twenty-five years ago, Samuel Insull, a strong man whom Destiny seems to have called with her tongue in her cheek, tucked a handful of middle western electric light companies into a still rather new fangled utility holding company and stepped out to become a lord of empire. Within a few weeks of Insull's fateful venture, a still green state senator from Dutchers County, New York, scraped acquaintance with electric power. That senator was Franklin D. Roosevelt, and his actions through the years have done much, as Insull's did, to influence, profoundly, the power age. They gave shape and substance to the coming power age. Between Insull's modest start in big league utility combinations in 1912 and Roosevelt's first espousal of public power in the same year there was no connection other than the virtual coincidence. Nevertheless, these two events, one in Chicago and the other in Albany, were the signs and portents of electrical revolution. The holding company career which led Insull to almost unbelievable triumph and disaster and Roosevelt's moves for public power have colored nearly all the noteworthy happenings in the domain of light and power in recent times to say nothing of times to come. This book presents the story of Insull's rise and fall and Roosevelt's rise and the wars over electric power past, present and to come. M. L. Ramsay, the author is a former Washington correspondent who, from 1925 has specialized in economic and public utility subjects. At present he is the Director of the Utilization and Research Division of the Rural Electrification Administration.

REFRIGERATION ENGINEERING, by H. J. Macintire. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Size 6 by 9 in., 408 pp., cloth bound. Price $4.50.

H. J. Macintire, professor of refrigeration at the University of Illinois, has long been recognized as a leader in the field of mechanical refrigeration and although this book is intended primarily for class room use, it is sufficiently detailed and complete to serve as a valuable reference book for the practicing engineer. Full attention has been given to the fundamental theory, that is thermo-dynamics, theoretical cycles of compression machines, refrigerants, flow of fluids, heat transfer insulation, evaporation and liquefaction, absorption and allied cycles. Practical applications have not been neglected and air condition, at present a very active phase of refrigeration, has received detailed treatment not only from the standpoint of comfort cooling but the broader applications of industry, cold storage warehouses and mines.

COMBUSTION ENGINEERING CO., Inc., New York, has just issued a catalog describing and illustrating the principle of controlled circulation as embodied in the design of C-E-Nuway fire-tube boiler. This boiler differs from the conventional horizontal fire-tube boiler in that a special arrangement of tubes and baffles provides a definite path of circulation, both downward and upward. Both the efficiency and the capacity are thereby improved and a quick response to fluctuating loads is provided. The catalog also describes the various construction details, includes setting drawings and tables of dimensions, and shows how the Elesco girth type of superheater can readily be attached.

NEW PIPE cutting and threading machines are described in a recent folder issued by The Curtis & Curtis Co., 190 Garden St., Bridgeport, Conn. These machines are designed for either hand, belt or electric motor drive and have such features as positive oil lubrication, automatic die release and automatic feeding.

REFRACTORY AND INSULATION CORP., 381 Fourth Ave., New York, has recently issued its bulletin No. R-31 dealing with No. 3000 refractory cement and describing its extensive application in setting brickwork and repair of refractory construction on boilers, industrial and domestic furnaces, coke ovens and other high temperature processing equipment.

DOMESTIC AND residential rates for electric current in cities of 50,000 population or over for 1924 to 1936 are tabulated and trends summarized in a report issued by Federal Power Commission. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for 15 cents a copy.

PROCEDURE Handbook of Arc Welding is issued in a reprinting of the fourth edition by Lincoln Electric Co., Cleveland, Ohio. New material includes 16 pages on the latest weld symbols, a new discussion on designing for arc-welded steel construction of machinery as to appearance, development and technique. Copies may be had from the company, price $1.50 postpaid.

REVISED RULES and Regulations on fuel burning equipment by the Department of Smoke Regulation of Hudson Co., N. J., are just issued, copies being available from W. G. Christy, Court House, Jersey City, N. J., on request with enclosure of six cents in stamps.

IRON FIREMAN MFG. CO., 3170 W. 106th St., Cleveland, has a new catalog on Poweram underfeed stokers, for boilers developing up to 300 hp. Changes in the 1937 line include new type rubber diaphragm volumeters for the control of the air supply and cold rolled steel feed worms.

GORTON HEATING CORP., Cranford, N. J., has recently issued its Bulletin No. 104 dealing with the Gorton high pressure air eliminator which is used for automatically venting driers, steam coils, traps, etc., under operating pressures up to 150 lb.

UNDER THE TITLE of Buromin, The Buromin Co., Pittsburgh, Pa., has recently published a bulletin dealing with boiler water conditioning which contains information on this chemical product used for maintaining boilers and feed lines free of scale. The bulletin also calls attention to the continuous service rendered by the company in the control of boiler water conditions.

CROSBY SAFETY and relief valves are made the subject of Catalog No. 101 recently issued by Crosby Steam Gage and Valve Co., 30 Church St., New York. This extremely attractive catalog, published in colors, contains a great amount of information and tables helpful to the engineer in solving his valve problems. Not only are the valves themselves described in considerable detail but the service to which they are adapted, installation instructions and operating precautions are given.

ROOTS-CONNERSVILLE BLOWER CORP., Connersville, Ind., has recently issued two new bulletins covering its line of rotary pumps, which are suitable for heavy duty. Bulletin 61-B10 describes and lists the new-type RF 3-lobe Cycloidal pump and Bulletin 55-B10 covers the application of certain Roots-Connersville units as exhausters for priming the larger centrifugal pumps.

LEEDS & NORTHRUP CO., 4901 Stanton Ave., Philadelphia, Pa., just issued a new 20 page booklet No. N-96S-744A, "To Improve Corrective Water Treatment," which describes the application of Micromax pH recording and controlling equipment for water treating purposes.

MECHANICAL and steam atomizing oil burners of the interchangeable type as made by The Engineer Co., 17 Battery Place, New York City, are described in Bulletin O-B 37 recently issued. In addition to the burners, the bulletin describes Enco fuel oil pumping and heating systems.

DIAL THERMOMETERS adjustable to any angle in relation to the stem and designed so that the bulb fits existing glass thermometer sockets, is described in a new bulletin of the American Schaeffer & Budenberg Div. of Consolidated Ashcroft Hancock Co. of Bridgeport, Conn.

MINIMUM recommended standards for steel fan housings are being distributed by the National Association of Fan Manufacturers, General Motors Bldg., Detroit, Mich.

THE HYDRAULIC INSTITUTE, 90 West Street, New York City, has recently published Section E of the Standards of Hydraulic Institute covering "Deep Well Turbine Pumps." It is available at a price of 25c.

DESCRIPTIVE BULLETIN No. 1 issued by Carnegie-Illinois Steel Corporation is devoted to a discussion of the properties and characteristics of electrical steel sheets. Those concerned with the design of electro-magnetic apparatus will find considerable valuable data in it.

LIMITORQUE CONTROL is the subject of a new 48-page booklet issued by the Philadelphia Gear Works, G Street, below Erie Avenue, Philadelphia, Pa.

THE FOURTH EDITION OF THE HANDBOOK OF INTERIOR WIRING DESIGN, has been published by Industry Committee on Interior Wiring Design. This is a book bearing the approval of the entire electrical industry written for those who want to know what good wiring is and what it means. It surveys the field of wiring adequacy for buildings, treating of the electrical needs of the residence, factory, office or store. It interprets modern practice in installing wiring and conforms with the requirements of the American Standard Codes set up for fire prevention and personal safety. Copies may be obtained from the Edison Electric Institute, 420 Lexington Avenue, New York City at a price of $1.00 for a single copy and at a lower rate when purchased in quantities.

COCHRANE CORP., Philadelphia, Pa., describes and illustrates its new straight-line, bucket type steam trap for condensate drainage at pressures up to 150 lb. in Publication No. 2663. It contains tables and charts for scientifically determining capacity ratings, with instructions on how to select proper size trap.

TECHNOLOGY AND THE MINERAL INDUSTRIES is a 63 page booklet prepared by the National Research Project, Works Progress Administration, in cooperation with the U. S. Department of the Interior, Bureau of Mines. The booklet summarizes in non-technical language the major changes discernible in the technology of mineral extraction and points out the probable effects upon the economic and social organization of the country and the relation of technology to employment. A small supply of these reports is available for distribution by the Works Progress Administration, 1734 New York Ave., Washington, D. C.

NEOPRENE, an engineering material with rubber-like properties, which resists the deteriorating effects of oil, heat, sunlight, chemicals and oxidation, is described in detail in a new handbook published by Rubber Chemicals Division, E. I. du Pont de Nemours & Co., Wilmington, Del. It shows specific applications to making hose, electrical cable, molded parts, sheet goods and gaskets. Copies of the booklet may be had on request.

KOPPERS COMPANY'S Western Gas Division at Fort Wayne, Ind., has just published for free distribution a new sluice gate catalog containing detailed drawings, specifications, and dimensions of gates in a wide variety of sizes for unseated and seated pressures. Sluice gate installation and operating methods also are shown in a series of diagrams, as well as diagrams and dimensions of floor stands.

INFORMATION on design and layout of piping for welded connections is contained in Design of Welded Piping, a 200-p. (6x9) booklet containing over 100 figures and tables, published by The Linde Air Products Co., New York. Subjects treated of interest to engineers are fundamentals of welded joint design; welding metallurgy; standard welded pipe connections; design data on welding cast iron, galvanized iron, stainless steel and non-ferrous piping; advantageous layout; fabrication and erection considerations; welded anchors and supports; and welding speeds.

CATERPILLAR tractors, road machinery and engines on various types of construction jobs are the subjects of a new 32-p. booklet just issued by Caterpillar Tractor Co., showing scrapers, generator sets, locomotives, hoists, and shovels as some of the items. Copies may be obtained free by writing Caterpillar Tractor Co., Peoria, Ill., for No. 4198.

BULLETIN No. 1510 recently issued by James G. Biddle Co., 1211 Arch St., Philadelphia, is devoted to Frahm Vibrating-Reed Tachometers which are used extensively on steam turbines and other rotating equipment because no contact whatsoever with the rotating shaft is necessary. Another use of these instruments is for measuring strokes per minute of pneumatic hammers and drills and also frequency of vibration. The bulletin illustrates many of these applications and devotes considerable space to the principles involved in the construction of these instruments.

COFFING HOIST CO., Danville, Ill., has issued a folder describing the uses of its advanced design ratchet chain hoists which are made in capacities ranging from ¾ ton to 6 tons. These hand operated tools are applicable to innumerable jobs around plants involving lifting, stretching, bending and pulling.

A NEW 12-PAGE bulletin on Bristol's recently developed Round Chart Potentiometers is announced for distribution by The Bristol Company, Waterbury, Conn. These instruments are available as temperature recorders and controllers—both pneumatic and electrically operating types.

HIGH EFFICIENCY rural line transformers, Type H A E, their construction and characteristics are described and illustrated in a leafiet, No. 2256, issued by the manufacturers, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

JOHNS-MANVILLE Bonded Built-up Roofs is the title of a 36-p. brochure containing complete specifications and drawings of J-M roofing materials and construction. For convenience an index and condensed table of specifications are listed. Various methods of base and cap flashing are outlined, with diagrams of how flashing should be installed. Roofing materials and their ability to stand up under fire, weather and wear are gone into in detail. Copies are available upon request to Johns-Manville, 22 East 40th Street, New York City.

LINCOLN ELECTRIC CO., Cleveland, Ohio, is revising its drafting room chart of data for arc welded designs to incorporate the latest weld symbols adopted by the American Welding Society, which are designed to make possible simplification of design and clear conveying of information to workmen. The chart is 24 by 35½ in., for wall mounting by metal strips at top and bottom, and includes, besides the weld symbols, types of joints, comparison of welded and riveted designs, tables of properties of metals, length and allowable shear load for fillets to replace rivets. The chart is suitable for blueprinting where several copies are needed, and may be obtained by request to the company.

JAMES G. BIDDLE CO., 1211 Arch St., Philadelphia, Pa., describes the Jagabi speed-measuring instruments as well as the Frahm vibrating reed hand tachometers in its recently published Bulletin 1505. These instruments, mostly of the hand type, are used for measuring speed in revolutions per minute, feet per minute, or other appropriate units. They include indicating tachometers, chronometric speed indicators, and vibrating reed tachometers.

ELLIOTT CO., Jeanette, Pa., in its recently issued Bulletin D-4 gives a great amount of information on feedwater heaters of the direct contact type. The bulletin is devoted mostly to showing photographs, both shop views and installations, the types of heaters covered include open heaters of both the spray and tray types, deaerating heaters of all types and sizes, thoroughfare type deaerating heaters, elastic-joint construction, and metering heaters.

WORTHINGTON sewage sludge gas engines are described in a recent publication issued by the Worthington Pump and Machinery Corp., Harrison, N. J. The pamphlet contains several views of installations with engines direct connected to rotary blowers or generators and gear or direct-connected to sewage pumps. Instructions are given by means of which it is possible to approximate the potential power that can be developed from the sewage of any particular city.

NEW BULLETIN No. 1972-B, issued by Ingersoll-Rand Co., 11 Broadway, New York, N. Y., illustrates the Cameron Motorpump condensate return unit and shows many of its applications. The bulletin also contains information regarding sizes and capacities.

Power Plant Construction News

Ala., Mobile—Aluminum Ore Co., East St. Louis, Ill., a subsidiary of Aluminum Co. of America, Inc., Gulf Building, Pittsburgh, Pa., plans installation of electric power equipment in new bauxite ore plant at Mobile, where large tract of land has been secured under long-term lease. It will comprise a number of large units; a power house will be built. Entire project is estimated to cost over $3,000,000. C. B. Fox is president.

Ala., Mobile—Standard Oil Co. of Louisiana, St. Charles Avenue, New Orleans, La., plans installation of power equipment, pumping machinery, steel tanks and other mechanical equipment in connection with expansion of bulk oil storage and distributing plant at Mobile. Entire project will cost close to $200,000.

Calif., Los Angeles—Swift & Co., 3750 Jewel Avenue, plan installation of electric power equipment in new additions to local meat-packing plant on Jewel Avenue, comprising several multi-story units. Entire project will cost close to $1,000,000. Main offices of company are in Union Stock Yards, Chicago, Ill.

Fla., Orlando—Orlando Utilities Commission has plans maturing for extensions and improvements in municipal electric power plant, including installation of a new 1500-hp. boiler unit and auxiliary equipment. A new stack will be built. Entire project will cost close to $600,000. Robert & Co., Inc., Bona Allen Building, Atlanta, Ga., is consulting engineer.

Ga., Thomasville—Water and Light Department plans extensions and improvements in municipal electric power plant, including installation of new turbo-generator unit and auxiliary equipment. Bids will be asked in near future. D. R. Pringle is superintendent of Department.

Ill., Chicago—Albert Schwill & Co., 141 West Jackson Boulevard, malt products, plan installation of power equipment in new additions to plant at Avenue C and 103rd Street, comprising a multi-unit malt house and grain elevator. Conveying, loading and other mechanical-handling equipment also will be installed. Entire project will cost $750,000. Galland & Henning, Milwaukee, Wis., are engineers for malt house unit; Adolph F. Eiserer, 332 South La Salle Street, Chicago, is engineer for grain elevator.

Ill., Chicago—Guy Rocco, 5242 West Division Street, Chicago, is at head of project to construct and operate two hydroelectric power plants, each about 9000-kw. installed capacity, at existing United States locks and dams on Des Plaines River at Brandon Road, and on Illinois River, Dresden Island. Application has been made to Federal Power Commission for permission.

Ill., Canton—International Harvester Co., 606 South Michigan Avenue, Chicago, Ill., plans installation of electric power equipment in connection with rebuilding of portion of branch plant at Canton, recently destroyed by fire with loss estimated close to $200,000. Adam Condo is superintendent at plant.

Ind., Fort Wayne—Board of Public Works, City Hall, will receive bids until Aug. 11 for expansion and improvements in municipal power plant, including new high-pressure boiler unit, stoker, soot blower, ash-handling equipment and other equipment. (All bids recently received have been rejected.)

Iowa, Storm Lake—City Council has plans under way for new municipal electric light and power plant, comprising three 500-kw. Diesel engine-generator units and auxiliary equipment. Special election has been called on August 25 to approve bond issue of $330,000 for project. Young & Stanley, Inc., Muscatine, Iowa, is consulting engineer.

Kan., Wichita—Bay Petroleum Corporation, Denver, Colo., plans installation of power equipment, pumping machinery and other mechanical equipment in connection with expansion and improvements in branch oil refinery at Wichita, formerly the property of Dickel Oil Refining Co., recently acquired. Entire project will cost close to $200,000.

Ky., Hazard—City Council has plans maturing for extensions and improvements in municipal electric plant and waterworks station, including installation of additional equipment. Fund of $25,000 has been authorized for work.

La., Norco—Shell Petroleum Corporation, Shell Building, St. Louis, Mo., plans installation of power equipment, pumping machinery and other mechanical equipment in connection with expansion and improvements in oil refining plant at Norco. Entire project will cost about $750,000. Proposed to begin work soon.

Me., Lewiston—Light and Water Department, Lewiston, has plans maturing for extension and improvements in municipal power plant and waterworks pumping station, including installation of Diesel engine-generator unit and accessories, pumping machinery and auxiliary equipment. Entire project will cost close to $200,000. Whitman & Howard, 89 Broad Street, Boston, Mass., are consulting engineers.

Md., Riverdale—Engineering & Research Corporation, Sligo Mills Road, Washington, D. C., plans installation of electric power equipment in new aircraft manufacturing plant at Riverdale, where tract of land has been acquired, consisting of two large units. A power house will be built. Entire project will cost over $100,000. Kubitz & Koenig, Emerson Tower Building, Baltimore, Md., are engineers.

Neb., Holdrege—City Council has authorized plans for extensions and improvements in municipal electric power plant, including installation of additional equipment. Estimates of cost are being made. Robert Fulton, 2327 South Nineteenth Street, Lincoln, Neb., is consulting engineer.

N. Y., Corning — Corning Glass Works, Corning, plan installation of electric power equipment in new additions to plant, comprising two multi-story additions, totaling about 236,000 sq. ft. of floor space. Entire project will cost over $500,000.

N. Y., New York—Consolidated Edison Co. of New York, 4 Irving Place, is arranging an appropriation of $42,000,000 for expansion and improvements in power plants and system during the next 12 months, including installation of equipment for increased capacity, transmission and distributing lines, underground conduit systems, etc.

N. C., Salisbury—Salisbury Coca-Cola Co., plans installation of electric power equipment in new bottling plant in southern part of city. Proposed to begin work soon. Entire project will cost close to $100,000. Temple A. Snyder is secretary and treasurer.

N. C., Tuckertown—Carolina Aluminum Co., Gulf Building, Pittsburgh, Pa., a subsidiary of Aluminum Co. of America, Inc., same address, has plans in progress for new hydroelectric generating station on Yadkin River, near Tuckertown, to be equipped for initial capacity of 54,000 hp. Output will be used primarily for service at company mines and mills in that vicinity and transmission line will be built for such purpose. Federal permission has been asked for project.

Ohio, Cincinnati—General Spring Co., 125 East McMicken Avenue, plans installation of electric power equipment in new one-story addition, 85x165 ft. Entire project will cost close to $65,000. Carlton, Frankenberger & Batson, 4122 Davis Lane, are architects and engineers.

Ohio, Cleveland—Cleveland Chain & Mfg. Co., Broadway and Henry Streets, plans installation of electric power equipment in new one-story and basement plant addition, 70x225 ft. Entire project will cost over $85,000. Herman W. Maurer, 3126 Scarboro Road, is architect.

Ohio, Dayton—Frigidaire Division, General Motors Corporation, plans installation of electric power equipment in new two-story addition to electric refrigerator manufacturing plant, 80x700 ft., on which work is scheduled to begin in August. Entire project will cost over $750,000. Schenck & Williams, Third National Building, Dayton, are architects.

Pa., Chester—Scott Paper Co., foot of Market Street, plans installation of electric power equipment in new addition to tissue paper mill. Entire project will cost close to $1,000,000. Proposed to begin work soon. Stone & Webster Engineering Corporation, 49 Federal Street, Boston, Mass., is engineer.

Pa., Lock Haven—Taylor Aircraft Co., Bradford, Pa., plans installation of electric power equipment in new airplane manufacturing plant at Lock Haven, where company has acquired former mill of Susquehanna Silk Mills, and will remodel and improve. Work is scheduled to begin soon. Entire project will cost close to $100,000.

S. C., Charleston — Raybestos-Manhattan, Inc., Willett Street, Passaic, N. J., plans installation of electric power equipment in new two-story branch mill at Charleston, for manufacture of rubber hose, in vicinity of local plant of General Asbestos & Rubber Co., an affilated interest. Entire project will cost close to $65,000.

S. D., Sioux Falls—John Morrell & Co., North Wells Street, Sioux Falls, has plans for new four-story cold storage and refrigerating building, 104x122 ft., at local meat-packing plant. Cost over $100,000, including equipment. H. Peter Henschien, 59 East Van Buren Street, Chicago, Ill., is architect and engineer. Main offices of company are at Ottumwa, Iowa.

Texas, Orange—Orange Pulp & Paper Company plans installation of electric power equipment in new addition to pulp mill, comprising several units for large increased capacity. Entire project will cost over $750,000. Proposed to begin work soon.